SCIENCE AND PHILOSOPHY

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PREFACE

The very welcome spread of education has considerably helped the dissemination of modern scientific knowledge. Atoms, electrons, quantum of energy, star galaxies, spiral nebulae, transmutation, metabolism, symbiosis, biogenesis, cells, gens, chromosome, complex, fixation, conditioned reflex, subconscious, libido—all these and many other terms are more or less freely used in the day to day conversation of the average educated man. The more ambitious dabble even in the obscure language of mathematics. The popular scientific literature grows in volume almost daily. But this very welcome radiation of scientific knowledge has not been an unmixed blessing. By and large, the immediate result has been like indigestion from unaccustomed rich food.

The otherwise valuable popular works of some eminent scientists rather tend to philosophise than contribute to the dissemination of simplified knowledge. They have created the impression that the latest developments of science, particularly of physics, conclude the agelong struggle between science and superstition with a victory of the latter.

Having gone through a book by Eddington, Jeans or some other philosophising populariser of scientific knowledge, the average educated man discusses controversial problems of philosophy with an air of authority. Such discussion is bound to cause confusion.

People with preconceived metaphysical notions read the popular scientific literature not with the purpose of widening their scope of knowledge, but to be able to talk learnedly about the philosophical implications of modern scientific research. Popular works of philosophising scientists usually treat particular branches of science—physics or biology or psychology. They cannot but give one-sided pictures. Any unbiassed philosophical deduction from the result of modern scientific research, however, requires a general acquaintance with an integrated picture of the totality of scinetific knowledge. The most outstanding feature of modern scientific research is to reveal that the enquiries carried on by the particular branches of science, physical as well as biological, are converging upon a common meeting ground. There may be divergent opinions about the nature of the converging point of modern scientific research. But no opinion in that respect can claim serious consideration, unless it is fairly well informed.

Yet, opinions about the philosophical implications of modern scientific theories are freely expressed dogmatically on the authority of this or that popular treatise by a philosophically biassed scientist.

The practical application of scientific knowledge has undoubtedly done a good deal of harm. Apart from the poison gas and atom bomb, technology has not been an unmixed blessing. Therefore we hear so much lamentation about the Frankenstein created by science. This regrettable situation has been brought about by an one-sided appreciation of scientific knowledge. Science not only enables man to conquer nature, but also helps him to understand nature, his relation with it and with other human beings who are integral parts of nature. In other words, scientific knowledge has a philosophical implication. As a matter of fact, science and philosophy have been interwoven from the very dawn of civilisation. Modern technological trends threaten to offer mankind at the altar of the Moloch, and create a Frankenstein lusting to devour its creator, because the practical, utilitarian value of scientific knowledge has been allowed to eclipse its ideal value, its contribution to pure thought, which alone enables man to behave rationally as well as morally, which

also provides the standard for judging right and wrong, truth and error, good and evil.

To make the philosophical implication of modern scientific knowledge clear, therefore, is of immense cultural importance. An integral picture of modern scientific knowledge, free from technicalities or academic obscurantism, is essential for the purpose. There are few such encyclopedic works as present the picture. They are usually too erudite for the understanding of the average educated man.

Having keenly felt the need for a book which would bring the totality of modern scientific knowledge and its contribution to pure thought within the comprehension of the average educated man, I utilised a long period of imprisonment to write it. Written under the restrictions of prison life, the manuscript was defective. It had to be filled in and amplified with materials not available to me in jail. Nevertheless, the major part of the manuscript was ready for publication years ago. But the war intervened. Even now, technical conditions for the publication of a book of several thousand pages in three volumes are not very favourable. There will be still some delay. But there have been pressing demands for early publication. It is hoped

that, pending the appearance of the larger book, a sort of a synopsis thereof may partially satisfy the demand.

In this book, I have formulated the philosophical problems posed by modern scientific theories, and indicated the rational unbiassed approach to them. Being a synopsis of the larger book, this volume naturally outlines the thesis developed in the former, the publication of which I hope will now be hastened. Meanwhile, this volume is expected to stimulate a fairly well informed discussion.

Dehradun, M. N. ROY.

September 1st, 1947.

CHAPTER I

Introduction

For the average educated man, the term philosophy has a very vague meaning, but sweeping application; it stands not only for speculative thought, but also for poetic fancy. In India, particularly, this vague, all-embracing, sense is generally prevalent. Philosophy is not distinguished from religion and theology. Indeed, what is believed to be the distinctive feature of Indian philosophy is that it has not broken away from the mediaeval tradition, as modern Western philosophy did in the seventeenth century.

Philosophical doctrines based upon faith, by their very unphilosophical nature, cannot naturally be tested by the standard of scientific knowledge. As a matter of fact, such doctrines deny that the standard of scientific knowledge can be applied to them. Their test, therefore, must be logical. Faith also has its logic, and the task of the critique of religious philosophy is to lay bare the fallacy of that logic. Take, for example, the idea of God. It results from the belief that the world was created once upon a time;

and no creation is possible without a creator. Physical research has exploded the doctrine of creation, and consequently rendered the idea of God, personal or impersonal, untenable. But the believer may disregard all the evidence of science and arguments of natural philosophy. We must meet him on his own ground. We must expose the fallacy of the logic of his faith.

The faith in God has a rational foundation. It results from the primitive man's search for the cause of things. God is postulated as the cause of the world. Now, if everything must have a cause, it is quite logical to ask who created God. The usual answer of religion, that God is eternal, only begs the question. The search for a final cause must lead to **regresso ad infinitum.** There is no reason why you should stop at God and call him the final cause. To do so is to abandon the notion that everything has a cause. Once it is admitted that something may be self-caused, may have its cause inherent in its own being, as done by postulating God as the final cause, there cannot be any logical objection to the view that the world is self-caused, that it was never created, that it is eternal. By finding causes of the natural phenomena in nature itself, science progressively reinforced this logi-

cally tenable position. So, the germ for the destruction of the belief in God is embedded in its own rationalist foundation. It may disregard the evidence of science and the arguments of natural philosophy. But it cannot stand the test of its own logic, which drives it into the fatal fallacy of **regresso ad infinitum.**

The purpose of this book is not to criticise this or that type of philosophy. It is to draw the philosophical conclusion of modern scientific theories. If it is found that modern scientific research does not lead to a mystic, spiritualist, view of nature, religious philosophy will be necessarily rejected. Because, neo-spiritualism is regarded as a vindication of religious philosophy, although its prophets may not be inclined to go so far.

Faith in the super-natural does not permit the search for the causes of natural phenomena in nature itself. Therefore, rejection of orthodox religious ideas and theological dogmas is the condition for philosophy. The growth of the natural sciences in the seventeenth and eighteenth centuries enabled modern Western philosophy to repudiate the superstitious creeds of religion, and throw off the domination of theological dogmas. The contention that modern physical research leads to a mystic-

spiritualist view of the world, means that, in the historic struggle against religion, science has been defeated. Idealism, in the classical form, cannot be resurrected. The neo-spiritualists, therefore, do not defend classical Idealism. They hold a mystic view: nature is inscrutable, it is impossible to know what the physical world really is; the nature of reality is beyond our ability to know. All this means that modern physical research compels a return to the faith in the super-natural. Even classical Idealism would not go so far. Because, it is based upon rationalism, having grown out of the revolt against religious superstitions and theological dogmas. To perform its function, philosophy must break away from religion, start from the reality of the physical Universe, and consequently head towards Materialism. Therefore, a mystic view of the world is negation of philosophy. It liquidates philosophy and resurrects faith.

If scientific research really compels us to take a mystic view of the world, then, philosophy must revert to its old occupation —to speculate about the hypothesis of a spiritual reality behind material appearances, about the postulate of a World Soul and its relation with individual souls, and such other problems that can never be solved by man,

himself limited by his material being. The ideal of human existence would, then, again become the accomplishment of an impossibility—realisation of the Infinite by the finite. If it is true that science has found it impossible to explain the phenomena of nature in terms, without assuming unknowable causes, then philosophy must relapse into the morass of idle speculation about problems that are insoluble by their very nature. The belief in super-natural forces would have to be revived. Religion would be restored in its old place of supreme authority. To speculate about the nature of God, as the embodiment of the super-natural, would be the highest intellectual occupation. But, if, on the contrary, it is found that a neo-spiritualism does not necessarily result from modern scientific research, then, it must be admitted that the historic battle between religion and science has ended in a victory of science. The historic battle between religion and science, superstition and reason, faith and knowledge, will still have to be fought in those countries where it has not yet been fought.

The fundamental problem of philosophy is to define philosophy. It can be defined as the theory of life. We may formulate the definition in another manner: the function of

philosophy is to solve the riddle of the Universe. Philosophy is the theory of life, because it was born of the efforts of man to explain nature and to understand his own being in relation to its surroundings; to solve the actual problems of life in the light of past experience, so that the solution will give him an encouraging glimpse into the future. Those efforts began as soon as man learned to think. In course of time, exigencies of his physical being brought him face to face with the necessity of finding causes of the phenomena of nature, so as to understand them and control them gradually. Life itself is an outcome of the cosmic evolution. Therefore, a comprehensive theory of life, a logical explanation of the becoming of man, his present being and future perspective, can be formulated only in the light of a sufficiently clear understanding of the entire cosmic scheme. A comprehensive philosophy embracing all the aspects of nature and life must, therefore, be based upon a cosmology.

Philosophy is older than religion. It is as old as **homo sapiens.** In the process of the intellectual evolution of man, reason appears earlier than faith. Instinct is the primitive form of reason; at a later stage of intellectual evolution, it still represents the

automatic, physiological, functioning of reason, which itself is a biological property of higher organisms. In a rudimentary form, it can be traced even in higher animals.

Our knowledge of animal psychology is still very inadequate. Nevertheless, sufficient data have been collected to indicate that faith does not enter into the mental make-up of higher animals, in whom the presence of intelligence and emotion is clearly discernible. Going a step further in the process of organic evolution, we find absence of faith in the primitive human being. Contrary to the prevalent notion, belief in God and soul is not inherent in human consciousness. It is not human nature to believe in the super-natural. Anthropological investigations have definitely repudiated that venerable dictum. Among primitive races, the notions of God and soul are absent. The earliest form of religion—animism—is preceded by the belief in magical power; and magic does not represent belief in the super-natural. It is not miracle. The faith in magic is the most primitive form of determinism—the crudest conception of nature as an order in which there are laws—effects following causes. The rationalist instinct, expressed in the crude form of determinism called magic, eventually led man to search for the cause

of natural phenomena. The earlier stages of spiritual development are marked with the conviction that everything must have a cause. This conviction is the mother of philosophy as well as of science.

The development of modern science made man progressively acquainted with the laws of nature. Philosophy, consequently, found itself in the position to conceive and explain the universe as a self-caused, self-contained, order. It is no longer necessary to assume super-natural forces for the purpose of explaining the order of nature—for offering a plausible solution of the riddle of the Universe.

Religion is an intellectual and moral need so long as it serves a philosophical purpose. The philosophical value of religion is in its rationalist core. Faith in the super-natural is characteristic of a pathological stage of intellectual development. As soon as conditions conducive to normal development are available to human intelligence, it outgrows the pathological state of faith. The defeat of religion by science is a logical outcome of the rationalist core of religion. To survive the defeat, or drag on a losing battle, religion must discard its rationalist core. That is to say, after the rise of modern science, all philosophical reason for the

existence of religion disappears. Once man has overcome the circumstantial disadvantages that compelled him to believe in the super-natural, he is bound to outgrow the religious mode of thought. If in one period of man's spiritual development the religious mode of thought is an intellectual and moral need, because it gives a pathological expression to his instinctive rationality, in a subsequent stage the disappearance of that mode of thought is equally necessary.

Religion is bound to be liquidated by science, because scientific knowledge enables mankind to answer questions, confronted by which in its childhood, it was compelled to assume super-natural forces or agencies. If the assumption really answered the questions, then, religion would have precluded the rise of science. But religion did not explain natural phenomena. It simply created a new set of problems, which overshadowed the original problems of existence. Once the explanation of natural phenomena was conveniently found in the assumption of super-natural forces, the attention of man was naturally pre-occupied with the nature and behaviour of those imaginary beings. The original problems of real existence were not explained; they were simply pushed aside; and consequently their solution be-

came impossible. But the problems remained. They are problems of human existence. Religion not only did not solve them, but focussing human attention on imaginary questions about the nature of God, soul, etc., obstructed their solution for a long time.

The rise of modern science represents reassertion of the fundamental trait of human nature—the spirit of enquiry. Human existence implies action. Man is not a passive observer of nature. His very being brings him in contact with his physical environments, compels him to act, and arouses in him the desire to acquire knowledge of them—makes him alive to the necessity of such knowledge. Indeed, the elementary knowledge of his physical surroundings is automatically acquired as of biological necessity. So, the development of science is determined by the laws of human evolution. The verdict of science must, therefore, be accepted as binding upon philosophy. Religion, in so far as it is a crude form of philosophy, must also bow before the verdict of science.

The spiritual progress of mankind is the result of efforts to answer the questions: why? and how? It is generally held that science is occupied with the latter, while the former is the share of phi-

losophy. If the first question is meant to be why the world is, then, it cannot be a question of philosophy. Because, so formulated, the question calls for the search after the final cause, the very notion of which is logically fallacious. The notion of final cause presupposes belief in determinism. If everything must have a cause, the causal chain must be endless. It cannot break off at a point, however distant. Therefore, the notion of final cause is precluded by the logic of the notion itself. It is self-contradictory. Occupying itself with the question why, philosophy takes on a religious character, because enquiry into a logically fallacious problem cannot be undertaken except on the basis of faith, which anticipates the result of enquiry. There are only two alternative answers to the question Why? The world is, because it is created and, the world is, because it is. Both the answers are incomplete. To be complete, the one requires the postulation of a creator; and then it ceases to be a conclusive answer. If the question Why? is logically valid as regards the world, it is equally applicable to the creator of the world. And the slippery road to **regresso ad infinitum** is opened before the unwary enquirer. The complete form of the other answer would be: The

world is because it is eternal. This answer requires corroboration, which is provided by science. The doctrine of creation can find absolutely no ground in science. The eternalness of the world is further proved by the fact, discovered by science, that its being and becoming are determined by laws inherent in itself. The first answer, in contrast, besides being logically fallacious, can never be verified. Therefore, it cannot be the answer of philosophy.

It is maintained that science cannot answer the question Why? If science cannot answer it, that is because the question is illogical as well as incomplete; because it is meaningless. An elementary condition for any fruitful scientific enquiry is to insist that the questions should be sensible. For, the nature and the form of the question often limit the freedom of enquiry and predetermine the character of the answer. You cannot expect an answer to the question Why? unless you say, why what? The question is incomplete because it leaves the nature of the enquiry vague. But stated in a formally and linguistically complete form, it can be answered by science, and alone by science. We can understand why the world is so as it is, only in the light of the knowledge of how things composing the world

happen. The laws of becoming reveal the nature of being. There is no other way to an understanding of the nature of being. The fundamental problem of philosophy, that is the riddle of the Universe, thus can be solved only with the aid of scientific knowledge.

The question Why is illogical, because by implication it admits non-existence as an alternative possibility. If you ask why the world exists, you mean that it might not be necessary for it to exist. We are required to conceive non-existence as something real, at least hypothetically. But non-existence cannot be conceived by existing minds. It is an entirely different matter to ask why the world is so. The implication of the question thus formulated is that it might be otherwise. The alternative possibility, tacitly admitted, is not non-existence, but some other form of existence. In this form, the question can be, and is, answered by science, which shows that the world is so as it is in consequence of laws inherent in itself; that the laws of its own being do not permit it to be otherwise. It is explained why the world is as it is, but the possibility of other forms of existence is not excluded. If the laws of its being were different, the world might have been different.

Although the posibility of its being otherwise is not excluded; the question whether the general laws of nature could be different, is meaningless as Henri Poincaré shows. Because, it would always be possible to refer natural laws, to-day considered to be fundamental, to more general laws. ("Derniers Passés") The laws of nature are not independent of the physical being that they govern. Nowhere are they found to exist by themselves. Their existence is inseparable from the physical being. In a sense, they are properties of the physical being, and are expressed through its medium. Their forms are determined by the medium of their expression. Modern physical research has discovered that the varying states of physical being are associated with specific forms of natural laws. They can be traced back, though it is not yet done fully, to one or a few general laws. So are the varying physical states also analysable to an initial general state; and what is regarded today as the "initial simple condition", may to-morrow be found to be a complex combination of more elementary units. The causal relation between the natural laws and physical being is really mutual. Thus, the causal chain of the cosmic process need not be traced outside the world—to a metaphysi-

cal final cause.

The question whether the world could be otherwise has only a momentary meaning, and it is answered affirmatively by the world itself. Every moment there is a different world; and in the same moment, there is a multiplicity of worlds. Every one of these innumerable, not merely possible, but actual, worlds, has a specific system of natural laws which govern its being and becoming. Rationalist theology maintains that God did not create the world; it is an automatic mechanism; God's function is to decide which of the innumerable possible worlds should be the actual world. The multiplicity of worlds being not a mere metaphysical possibility, but an actuality, in space as well as in time, God is no longer required even to perform the selective function.

With the disappearance of the notion of creation, disappears one of the oldest problems of philosophy, namely, did the world originate in chance or of necessity? The physical world being without a beginning, as science shows, the question about its origin becomes irrelevant. If the question how it originated is irrelevant, the question why it exists is even more so. The world exists because it is eternal. Indeed, the question, why the world exists, is **prima facie** absurd.

To become the point of departure for a fruitful philosophical investigation, the question must be stated in an intelligent relevant form—why the world is so? Philosophy can answer this question only in the light of scientific knowledge. The knowledge of how things happen in it, enables us to explain why the world is as it is. The same knowledge also enables us to regard such traditional philosophical concepts as eternity, infinity, immortality, in a new light. Modern scientific research has put in these venerable concepts contents of concrete reality. It is remarkable that, while eliminating the necessity of the belief in God, modern scientific research brings within human comprehension notions that were traditionally associated with a super-natural spiritual being.

CHAPTER II

REALITY AND APPEARANCE

The epistemological significance of the recent achievements of physics as well as biology (including psychology) largely contributes to the solution of the old problem of perception. Philosophy has always tried to answer the question: How is knowledge possible? Even after experience had been generally accepted as the means to all knowledge, epistemology was confused and vitiated by the distinction between appearance and reality. The doctrine that reality is metaphysical sets a limit to knowledge. This doctrine eventually culminated in the Kantian unknown and unknowable thing-in itself. The contention was that we could acquire knowledge only of the world of phenomena; the world of reality is beyond the reach of our cognitive faculty. In the light of relativity physics, the distinction between reality and appearance disappears. Consequently, a more promising approach to the baffling problem of perception is discovered. Of course an actual solution of the problem must be offered by biology. The

physical principle of relativity provides the general philosophical guidance to the enquiry which, as it will be shown in a subsequent chapter, has produced results more satisfactory than ever before.

The solution of the problem of perception, in its turn, dispels all doubt about the objective validity of knowledge acquired through experience. This fundamental achievement in the realm of epistemology guarantees scientific philosophy against any idealist deviation. By scientific philosophy I mean a theory of the Universe not based on speculation, but on a progressively exact knowledge of nature. Even positivism is rendered untenable. In short, epistemologically, the philosophical outcome of the twentieth century science is corroboration of Materialism. It bears out the materialist theory of cognition.

Before proceeding, I shall quote the opinion of Professor Hans Reichenbach of the University of Berlin, who apparently takes up a neutral attitude in this connection. In a highly instructive and interesting work, Professor Reichenbach writes: "Philosophy has always distinguished the two fundamental attitudes of Empiricism and Idealism. The natural science of to-day has given the victory to neither of these points

of view. The fundamental idea of Empiriicsm, that only experience can decide on the validity of natural laws, is retained with all emphasis; but the principle of idealism, that only the combining of observed facts with laws created by thought constitutes science, is equally fundamental for the modern knowledge of nature. The constant application of the inductive principle expresses the empirical tendency of modern science. The belief in the unlimited correctness of induction is the essence of the empirical way of thinking. Natural science is far from attributing to this universal validity of the laws of nature any mysterious basis in metaphysical necessity. Nowhere is the anti-metaphysical attitude of modern natural science so obvious as in this conception of the problem of validity. We may also define it as the removal of the theistic element from nature. The metaphysical concepts of time and space, of substance, force and law, all of them of unmistakably anthropomorphic origin, to-day mean but a pictorial appendage unrelated to the experiences on which physical knowledge is really based. Only these experiences and their integration in a prophetic mathematical theory form the content of modern natural research. Perhaps there has been no greater revolution in the history

of mankind than this gradual transition from the nature, full of gods, of primitive peoples, through the metaphysical nature of the philosophers, to the dispassionate nature of physics to-day, in which there are only facts and conceptual relations between them." ("Atom and Cosmos").

Science is not all fact, nor is it the product of pure thought, that is, speculation. As Einstein says, "The object of all science is to co-ordinate our experiences and bring them into a logical system." Science thus stands on two legs, so to say: experience, that is, observational data, and their co-ordination into general laws. The former is derived from the "external world", while the latter is the contribution of the scientist. Unless the mind of the scientist, equipped with previously acquired knowledge, worked up the raw material of observed facts, there could be no new scientific theories. The previously acquired knowledge was derived from experience, and the new theories create the condition for further advance of our knowledge. Scientific theories are not spun out of the brain of the scientist. He indispensably needs the raw material to work up, with the aid of his skill. In order to co-ordinate experiences into a logical system, he must have experiences to begin with.

Thus far it is clear enough. But here arises the question: experience of what? If the answer is that it is the experience of objects existing outside the consciousness of the knowing subject, then, philosophy becomes straight-forward materialism, which by no means excludes the subjective element of knowledge. Is this the answer of modern science? We shall see.

Experience presupposes a conscious being, differentiated from the rest of the world; but the conscious being itself grows out of the background of physical nature, and, while experiencing the rest of nature, remains a part of nature. As a matter of fact, "external world" is a misleading term. Because we are all integral parts of the world of our experience. Our bodies, our organs of perception, the entire cognitive apparatus, which are prerequisites for knowledge, are themselves all parts of the world we experience. We do not watch the world as outsiders. Our ego, our mind, our intelligence, our thought—all these are inseparably interwoven with the so-called external world. These subjective constituents of knowledge are parts of the whole complex of the objective nature.

The empiricist-idealist synthesis, spoken of by Professor Reichenbach, means that

knowledge is the product of experiences coordinated into a logical system with the aid of conventions and methods invented by the mind of the scientist. This exactly is the materialist theory of knowledge. Empiricism, which would differentiate itself from materialism, could never serve the purpose of scientific research. For, the point of departure of all scientific investigation is the recognition of the physical existence of objects. Scientific research becomes meaningless when physical reality of nature is denied. There can be no experience when there is nothing to experience. Inference and induction are parts of experience. They are essential for framing scientific theories. If it is maintained that one cannot claim to have the experience of heavenly bodies, unless he has actually visited them physically, no astronomical theory would be possible. According to "pure" empiricism, optical experience is not a valid source of knowledge. What is seen through the telescope is not a distant star, but simply an image on the retina of the astronomer's eye, caused by light coming from the star. Astronomical theories are all inferential; the only way to the discoveries of the laws of nature is induction—to formulate general principles on the basis of the experience of a sufficiently large

number of particular events.

Inference and induction are methods of thought. They represent the subjective contribution of the scientist to the process of cognition. The raw material of experience must be cast in the moulds of concepts to become the finished product called the knowledge of nature. But these moulds are not à priori categories. They are themselves made up of previous experiences, and consequently change under the impact of new experience. The revolutionary significance, in the epistemological sense, of the twentieth century physics is that it has acquired a body of experience which cannot be fitted into the moulds of old concepts. New conceptual moulds must be created to suit the new experience. It is thus once again proved that thought is determined by being. That is the cardinal principle of materialist epistemology, which nevertheless admits that ideas, once they are formed, have a relatively objective validity, and are indispensable factors in the process of acquiring more and greater knowledge.

This point has been stressed, from the other side, by eminent biologists like Haldane and Huxley. Haldane is of the opinion that a living organism cannot be correctly studied as an object isolated from inanimate

nature; that it must be regarded as inseparably interconnected with its environment. The organism, together with its environment, constitutes one single unit. He holds: "The conception of life embraces the environment of an organism as well as what is within its body." Huxley is even more explicit. He writes: "The fact that man, a portion of the general stuff of which the Universe is made, can think and feel, aspire and plan, is itself full of meaning, but the precise way in which man is made, his physical construction, the kinds of feelings he has, the ways in which he thinks, the things he thinks about, everything which gives his existence form and precision—all this can only be properly understood in relation to his environments. For, he and his environments make one interlocking whole."

Physics, from one end, and biology, from the other, have converged on a place where the term "external world" has lost all meaning. In the light of that great discovery of modern science, the artificial distinction between appearance and reality must disappear.

Now we shall turn to the question: experience of what? Do we experience the reality or merely the appearance? In view of what has already been said, this question

no longer arises. Yet, the philosophical problem, which results from the discoveries of modern physics, is epistemological. Therefore, the question must be examined more closely, on its apparent merit.

The scientists, who deduce a neo-spiritualist view of the world from the discoveries of twentieth century physics, do not deny that experience is the source of knowledge. But they maintain that the object of our experience is not the external world; that it is our own sensation, and we have no means to ascertain how far our sensations correspond with the objects, by which they are produced. In other words, according to them, we experience the world as it appears to us; the reality is never accessible to our cognitive faculty.

In support of this view, it is pointed out that the familiar world of experience—of colour, sound, taste, touch, smell—is not the world of physics. The world, studied and described by physics, is composed of abstract concepts. It does not know anything about the "secondary qualities", which affect our senses. Hence it is concluded that the phenomena we experience have no objective being. They are products of our perception, and as such are only inherent in consciousness. If the direct content of experience, in

other words, the categories of consciousness, are accorded physical reality, then the world of physics indeed becomes a background of mere metaphysical concepts, illusive shadows.

As a matter of fact, it is maintained by the neo-spiritualist interpreters of the modern physical theories, that the object of the investigations of contemporary theoretical physics is a metaphysical something, unknowable. That is nothing less than liquidating physics. It is going even farther than the Kantian position. The neo-spiritualists would not concede physical reality even to the "thing-in-itself". They say that modern physics has not only got rid of the concepts of substance and casuality, but has reduced the world to a bunch of mathematical formulas. In other words, there is no physical background to the phenomenal world of our experience which exists only in our consciousness. What we experience does not exist for physics; that is to say, it is physically unreal. The world of physics is a mathematical construction. The world of noumenon as well as of phenomena has no objective reality. Both are projections of our consciousness. Consciousness is the sole reality. So, the question of knowledge does not arise. Knowledge is not possible. Has

science, after several hundred years of ambitious progress, reduced its votaries to this pitiable state?

In order to find out for ourselves what solution modern science offers for the problem by abolishing the arbitrary distinction between appearance and reality, we shall have to look at the world of new physics. And in order to see the picture from a correct perspective, it will be necessary to be guided by the fundamental principles of science and philosophy and to have a clear idea about the relation between the two.

CHAPTER III

SCIENCE AND PHILOSOPHY

Undoubtedly, modern scientific theories have profound philosophical significance; it is to render the old division of labour between science and philosophy untenable. Science is stepping over the old boundary line. Digging deeper and deeper into the secrets of nature, science has come up against problems, the solution of which was previously left to philosophy. Scientific enquiry has pushed into what is traditionally regarded as the "metaphysical" realm. But there is absolutely no evidence in support of the contention that the latest discoveries of physics negative the philosophical implications of the development of science during the last hundred and fifty years.

Philosophical speculations of individual scientists, when critically examined, are not borne out by the theories of modern science. The decisive factor is not the personal opinion of any scientist, but the logical implication of theories resulting from scientific research in general. The total body of repeatedly verified facts, collected through

observations and experiments, is the basis of legitimate philosophical deductions.

One of the essential features of scientific enquiry is disregard for authority. Philosophical views of scientists must be set aside as personal predilections, resulting from their cultural background, when they run counter to the general trend of scientific research. Macdougall is, so to say, the last of the Mohicans of orthodox psychology. Yet, in his famous book "Modern Materialism and Emergent Evolution", he writes: "A Newton, a Pupin, a Lodge, may tell us impressively of his religious and moral convictions, but these convictions are not the conclusions, to which he is led by his physical research."

Leibniz complained that Newton had robbed God of all his attributes and undermined the foundation of religion. Yet, Newton himself was a profoundly religious man, steeped in theological prejudices. In his old age, he composed some very silly theological treatise. Differentiating between the philosophical significance of scientific knowledge and opinions of individual scientists, Professor Hyman Levy writes: "It has taken several centuries for the scientific movement to be emancipated from just these cramping human assumptions. The writings of many

scientists show, alas, that the emancipation has not yet been completed. But no individual can be the spokesman of a movement. Each is a mirror that reflects, however imperfectly, the movement of which he is a part, but the image is coloured and distorted by his own history, from which he cannot disentangle himself. The movement transcends the man. He imposes his private and personal prejudices upon it at the risk of his own confusion. Only a genius can be greater than the movement, and such a genius is a rare event." ("The Universe of Science").

The philosophical significance of modern science is that it is disputing the claim of philosophy to an autonomous existence. The problems of philosophy—cosmological, ontological, epistemological—can all be progressively solved only in the light of scientific knowledge. That light burns brighter to-day than ever before. In his book "Atom and Cosmos", quoted above, Professor Hans Reichenbach writes: "Perhaps the characteristic trait of modern methods of physical research is nowhere so clearly expressed as in the trend from the philosophical to the physical; the physicist has become a philosopher, because, in developing his theories, he came to barriers which had to be broken open before new and unknown land could be

conquered."

The function of philosophy is to explain existence as a whole. An explanation of existence requires knowledge of existence. Knowledge about the different phases of existence is gathered by the various branches of science. The function of philosophy is to co-ordinate the entire body of scientific knowledge into a comprehensive theory of nature and life. The function of science is to describe; that of philosophy is to explain. Therefore philosophy is called the science of sciences.

But even to-day, there are philosophers who claim that an omelette can be made without eggs; that the function of philosophy is not to work out the materials supplied by scientific research into a theory of nature and life, but to lay down the patterns for scientific knowledge. Whitehead is one of them. In the preface to his book "Science and the Modern World", he writes: "Philosophy, in one of its functions, is the critic of cosmologies. It is its function to harmonise, re-fashion and justify divergent intuitions as to the nature of things. It has to insist on the scrutiny of the ultimate ideas, and on the retention of the whole of the evidence in shaping our cosmological scheme. If my view of the function of philosophy is correct,

it is the most effective of all intellectual pursuits. It builds cathedrals before the workmen have moved a stone, and it destroys them before the elements have worn down their arches. It is the architect of the buildings of the spirit, and it is also their solvent: And the spiritual precedes the material."

Modern scientific theories challenge these pretensions of philosophy. On the other hand, they may be woven into the patterns produced by the pretensions of the philosopher. But their real philosophical significance may be entirely different. That significance should not be allowed to be confused by the prejudices and predilections of individual scientists.

When physics attacks the "metaphysical" realm, it does not lend itself to mysticism. On the contrary, brought under the jurisdiction of physics, metaphysical categories cease to be mysterious. Of course, in the attack upon metaphysical problems, the old weapons of physical research are not adequate. Physics to-day deals with categories which defy direct experience. Even the finest instruments of observation are of no avail. Mathematics is the main instrument of theoretical physics. But mathematical symbols represent physical entities; in any case, entities which exist outside the

mind of the scientist. Otherwise, results obtained through highly abstract mathematical reasoning could not be verified by the observable facts of nature. Mathematical equations are not empty conventions. They describe relations between physical events.

The categories of modern physics are "metaphysical" in the sense that they are beyond the reach of direct physical observation. But it is long since metaphysics has outgrown its original literal Greek meaning. Natural sciences pushed the boundary between the physical and the metaphysical farther and farther at the expense of the latter. Every instrument of observation, which extended the reach of the physical organs of sense, meant an encroachment upon the metaphysical realm. To-day, the boundary line between the physical and the metaphysical can be retained only as a logical formality.

The metaphysical realm used to be marked off from the world of experience by the distinction between reality and appearance. New physics abolishes that distinction. The world of physics is metaphysical, in the sense that entities composing it cannot be directly experienced. But they are no longer regarded as **a priori** categories. The metaphysical foundation of new physics

is a posteriori deductions. Its physical reality has been experimentally established. This fundamental achievement of new physics disposes of the orthodox doctrine that metaphysical concepts are constructions of pure logic; that metaphysical propositions are analytical, they cannot be empirically proved; that metaphysical knowledge has no empirical validity.

Everything subject to physical observation, by our sense organs, must exceed a certain minimum dimension. There is no reason to suppose that, on the limit of direct physical observation, objects undergo a qualitative change. Yet, except on this dogmatic supposition, it cannot be maintained that "metaphysical" entities are essentially different from the things of the world of experience. Dualism results from the supposition that the "metaphysical" entities are essentially different from the things of the world of experience; and dualism vitiates philosophy.

Philosophy has always disliked dualism, because of its essentially theological implications. Modern scientific philosophy is decidedly opposed to any dualist doctrine. Dualism has haunted modern philosophy ever since the day of its founder. Descartes freed philosophy from theology, but placed

it under the hegemony of the mind, which he conceived as an immaterial substance. The antithetical concepts of mind and matter, essentially different, could not be reconciled by speculative thought. The development of natural sciences brought the reconciliation within reach. Modern psychology, aided by physiology, began to unravel the mysteries of the mind. The old static conception of matter still stood on the way to the final solution. There appeared to be an unbridgeable gulf between the external world of ponderable matter and the world of mind. With its dynamic conception of matter, new physics has successfully taken the last hurdle.

Having abolished dualism, ontologically (between the physical and the metaphysical), as well as epistemologically (between matter and mind), new physics has debunked metaphysics. An **a posteriori** system of metaphysics, if the term is still to be retained, which remains as an integral part of scientific philosophy, offers no ground for mysticism.

By its very nature, science can never go mystic. Its function is to acquire knowledge. Science is not omniscient. But it stands firmly by the claim to know. Mysticism results from ignorance. It makes a

virtue of ignorance. It represents a surrender of the claim to know. It doubts the possibility of knowing. In reality, mysticism implies an admission of defeat. The hackneyed expression—"inscrutable nature" —now finding favour, curiously enough, even with some scientists, implies an admission of defeat. They, however, use it rather in the poetic than scientific sense. The traditional idea was that the secrets of nature could not be penetrated; no use making further efforts; let us give it up. To maintain that modern science, and physics, of all, has any reason to be in such a defeatist mood, is to betray a deplorable ignorance of the glorious history of science, of the triumphant march of scientific knowledge during the last three hundred years.

Bertrand Russell writes: "Science has two purposes. On the one hand, there is a desire to know as much as possible of the facts in the region concerned; on the other hand, there is the attempt to embrace all the known facts in the smallest possible number of general laws." ("Analysis of matter"). These purposes are obviously irreconcilable with any brand of mysticism—metaphysical, logical or out-and-out spiritualist. New physics has not learned all the facts concerning the region of its research. It knows there is

much more to learn; and it proposes to push ahead with the purpose. It knows no myscism which rests content with marvelling at the unknowable.

The other purpose, with which Russell credits science, not only makes it the helpmate of philosophy, but inspires it to invade the realm of metaphysics, if the old mother is either too proud or too conservative to learn from the experiences of her enterprising daughter. General laws of science have philosophical validity. Only in their revealing light can the problems of philosophy be solved. Laws of science represent a knowledge of nature. Knowledge of nature enables us to tackle more successfully the problems of existence—of life, life being a part of nature. As an epistemological sceptic, Russell, of course, does not grant ontological validity to the laws of science. In his opinion, they are mental constructions, and are only logically true. That, however, is a different question, which cannot be treated here. The point, however, is that Russell is also of the opinion that, by its very nature, science gradually invades the preserves of philosophy, and experience becomes the infallible key for the solution of all philosophical problems. When the boundary line between science and philosophy thus disap-

pears, no room is left for mysticism. New physics represents a great advance towards a grand synthesis of human knowledge.

Thomas Huxley's famous dictum that "science is organised common sense" has lately fallen into disrepute. But despite all positivist sophistry, and epistemological sophistications, Huxley's definition of science still holds good, generally. By common sense Huxley meant instinctive recognition of the reality of the physical world. That recognition results from the primitive reaction of an organism to its surroundings. The philosophical import of Huxley's dictum is to lay stress upon the ontological basis of scientific knowledge. In these days of fantastic epistemological extravagances, which all but deny science any ontological validity, a little moderating influence of old-fashioned commonsense, may keep the balance in philosophical discussions.

It is useful to remember that awareness precedes knowledge, and awareness is a mechanical organic reaction. One must be aware of a certain object before he begins asking questions about it; and in course of the enquiry, thus initiated, he progressively acquires exact knowledge about the construction of a thing, about its properties, and its relations with other things. Primitive

awareness, however, does not directly lead to accurate knowledge and intelligent judgment. A minimum cultural progress and technological equipment are prerequisites for the process. In the absence of these, there is speculation instead of enquiry, and the result is mystification, not knowledge. Thus, crude common sense, that is, the instinctive belief that, when we see a thing, we do see a thing is likely to give rise to all sorts of absurd notions. But "organised common sense" is a different thing. It is the healthy, primitive, ontological sense, plus reason.

While defining science as organised common sense, Huxley declared: "The vast results obtained by science are won by no mystical faculties, by no mental processes, other than those which are practised by every one of us, in the humblest and meanest affairs of life. The man of science simply uses with scrupulous exactness the methods which we all, habitually and at every moment, use carelessly." This makes the meaning of the term "organised common sense" clear and precise.

Scientific knowledge is the result of observation, experiment, reflection, selection and co-ordination. Mind's function in the process is obvious, and is not minimised in

the least. Rationalist rigor and a high level of intelligence are necessary to guarantee "scrupulous exactness" in the process. But the primacy of the object of knowledge is emphasised.

Common sense distrusts strangeness. It is not easily taken in by mysteries and miracles. It demands explanation of phenomena that do not fit into the given order of things. It is primitive belief in causality. Common sense takes it for granted whenever things happen in the usual course; but it demands an explanation whenever an usual thing does not happen, or something unusual happens. Savage ideology is strictly deterministic. Magic, animism, primitive religion—all spring from the instinctive belief that everything must have a cause. The belief in causality is so deeply woven in the texture of consciousness, because the process of organic evolution is itself determined. Whatever may be the genesis of common sense, it represents the unerring sense of physical existence, the rudimentary ontological sense, which is the condition **sine qua non** for all knowledge, acquired progressively through an endless process of discrimination, differentiation, criticism, selection, penetration and refinement.

Einstein testifies that new physics has

not abandoned the old-fashioned common sense methods. He says that "the object of all science is to co-ordinate our experiences and bring them into a logical system." This may appear like reducing science to intellectual gymnastics, as Dirac, for example, tends to do. But a second reading of the short passage dispels the first wrong impression. Experience is placed in the centre. Experience supplies the raw material. The recondite mathematical formulas of new physics could not be spun mystically out of mental processes, unless experience supplied the raw material. As the object of science is to co-ordinate experiences into a logical system, obviously, experience is the basis of scientific knowledge. To the sophisticated question: experience of what?, Eeinstein's answer is characteristically direct and disconcertingly unmistakable. He believes in old-fashioned common sense. He says that no scientist really believes himself when he talks sceptically about the physical reality of the external world. One cannot doubt physical reality, and be a physicist at the same time. Why should an astronomer spend his life gazing at distant stars through high-power telescopes, if he did not believe that the stars really existed. If he were honestly convin-

ced that they were projections of his own mind, or mere mathematical constructions, why should he bother with the instruments of physical observation and measurement? Introspection would give him the same result. But no astronomer has yet left his observatory—not even Eddington or Jeans, nor has any physicist deserted the laboratory.

The positivist may indulgently smile at the naive realism of the **enfant terrible** of the modern world of science. But scientists cannot disregard the basic fact of existence, that awareness precedes knowledge; and scientific investigation must place ontology before epistemology.

The new physics follows the classical scientific method which, being essentially guided by sound common sense, has no patience for mysteries and miracles. All sorts of strange facts may be discovered when the investigation is pushed into hitherto unknown regions. As soon as something strange turns up, an explanation is demanded. The enquiry goes on untiringly until all the discovered facts, old and new, are coordinated into a logical system. Meanwhile, the strange fellows naturally arouse curiosity, attract general attention, and provoke speculation which may tend to step over the

limits of scientific method. But, for science, they represent only a problem to be solved, which can be solved and will be solved.

Discovery of new facts is the condition for greater knowledge. And when the facts are really of a new order, old theories require amending. The discoveries of new physics, instead of encouraging mysticism, have just the opposite philosophical implication. The following, written by the American philosopher Charles Pierce well ahead of time, has a much greater bearing upon the present state of our physical knowledge than all the contemporary mystic-metaphysical speculations.

"Experience teaches by means of a series of surprises. It is through the conflict of our explanations with what happens in reality, that we learn. Even in scientific experiments, nothing is learned from an experiment which only confirms a prior hypothesis; it is the surprise of a new disclosure that counts. This element of surprise, moreover, indicates interaction between the self and the world, and so disproves any subjective idealism."

There is still another stratagem for going around the difficulty of the external world, without which no physics is possible. But it only spoils the case of subjective ideal-

ism. Professor Hermann Weyl, writes: "Physics is not at all concerned with the material contents of reality; what forms the subject of its knowledge, is a simply formal view or statement of it." ("Space, Time and Matter") This formalist attitude towards the external world does not solve the question of existence; nor can the question be suppressed by simply ignoring it. But the modest scientist refuses to philosophise. He still desires to maintain the division of labour. He says: I have performed my function—described reality; now let the philosopher do whatever he pleases with it. Only, the scientist's description is so nearly complete as leaves philosophy little freedom. The explanation is compelled. Science needs no longer be respectful about the "thing in itself" which philosophy placed beyond its reach. When the description tells all about the properties, functions and relations of reality, it reveals the nature of reality. In any case, the explanation of the nature of reality must be done in the light of the description of the forms of reality, whether it is done by the scientist or left to the philosopher. If the philosopher won't see the light, and stupidly persist groping in the dark, the scientist must do his own philosophising. It is all but a matter of formality. Scientists'

description has become the explanation.

What Weyl really means is that physics can describe only the process of becoming; being is a metaphysical conception, which need not be postulated for the purpose of physics. But the metaphysical concept of being can be really eliminated only by suppressing the dualist notion of being and becoming. That requires a dynamic conception of matter. The new physics provides that. It has discovered that the something which distinguishes the world from nothing is being and becoming at the same time. Absolute being can be conceived only in abstraction. Becoming is the essence of being. The stuff of the world is not static, but dynamic. It is never in an inert state. Wherever it is, it is in the state of becoming. In the absence of becoming, there is nothing; being becomes real in becoming. But, on the other hand, absolute being, that is, being abstracted from becoming, is conceivable logically, whereas becoming logically presupposes being. It can take place only on the background of being.

Even Jeans bears out Einstein's assertion that physicists do not believe themselves when they apper to make a mystery of the physical world. Having stated the position of new physics, in the words of Heisenberg,

he goes on to admit: "This is not meant in any way to suggest that an objective nature does not exist, but merely that it is at present beyond our purview." ("The Background of Science"). The disrepute is not about the reality of the external world, but about the nature of the external world. In the place of the old common sense view, we are now given a variety of sceptical, non-commital, semi-idealistic theories.

Descartes said: "Give me matter and motion, and I will construct the world." Eddington now improves upon him and says: "Give me a world—a world in which there are relations—and I will construct matter and motion." ("Space, Time and Gravitation") Presumably, he means to say that matter and motion are creations of the scientist's mind. But he must have "relations"; and relations presuppose things related. They may not be as coarse as the "solid lumps of reality" of classical physics. But there must be something to be related. Then, you still need a world, given to you, that is, objectively existing. What Eddington really means, then, is that new physics has analysed the physical world to constituents finer than those of classical physics. Matter and motion remain, but not as ultimate categories, not as elementary indefin-

ables.

Similarly, "order", "events", "neutral stuff", "tensor impulse in the four-dimentional continuum", "something that fills space"—all these picturesque substitutes for the old conception of matter denote something which exists outside our mind; something which distinguishes the substratum of the phenomenal world from nothing. The question is about the nature of that something, the existence of which is not disputed.

If it is immaterial, why not say so? But that would be taking up a dangerous position. Absolute idealism is a double-edged sword. It throws matter out of the front-door only to let it in by the back-door. Instead of reducing the material world to a ghostly reality, absolute idealism legalises it. As the "emanation", "crystallisation", "incorporation", of absolute idea, material things acquire a real, not ghostly, reality. And once you let the devil in, it slips into the place of primacy. Plato, Descartes, Hegel—all served the cause of materialism. The scientific spiritualists of our time cannot take up a bold, consistent position without ruining their whole case. Hence their love for mysticism, which is useful for confusing issues.

CHAPTER IV

NEW PHYSICS

Classical physics pictured the world as follows: There are indivisible particles of matter, each having a constant mass. The particles persist through all time, each occupying a definite point in space, at each instant of time. Each particle exerts force upon other particles, the effect of which is to produce acceleration, that is, deviation of the particles from their respective rectilinear paths. Acceleration is inversely proportional to the mass of material bodies. All physical systems—stars, planets, stones, trees, animals, men—are more or less complicated combinations of indivisible material particles, having continuity in space and time, exercising mutual influence, according to strictly deterministic laws.

The world of new physics is built of protons and electrons. They are constituents of the material particle—atom—of classical physics. As its constituents, protons and electrons must be also material entities. But they, particularly the electron, which may turn out to be the more basic unit, are not

like the material particles of classical physics, because they do not seem to have continuity in space and time; and in the absence of continuity, it is not possible to assert that their mutual interactions are governed by any strictly deterministic law.

On the face of it, the difference appears to be considerable, even fundamental. Ponderable matter is gone. The world of new physics is made of an attenuated stuff which hovers on the boundary line between matter and energy. The tangible units of this elusive stuff, having no simple location in space and continuity in time, appear to defy determinism. If determinism goes, the mechanistic conception of the Universe must also go. On the top of all this, the concepts of space and time have undergone a veritably revolutionary change. Absolute space and the uniform flow of time are gone. Spatial and temporal separation between two objects are not constant for all observers. The further we go, the picture becomes even more perplexing. Space is curved. Time has no independent existence. It is mixed up with space. Indeed, space, time, matter—all three are merged into a four-dimensional continuum, in which events take place.

Ether has been thrown out of the new world of physics; and the same disgrace has

befallen an older member of the Cosmos, namely, Newton's "Force of Gravitation". Most disconcerting of all, however, is the discovery that energy does not flow continuously; it has an atomic structure. The quantum phenomena have until now defied all efforts for the co-ordination of the entire body of modern physical knowledge into a logical system, having a relation of continuity with the theories of classical physics. Not only are the quantum phenomena irreconcilable with old physical ideas; they even contradict the Theory of Relativity. While the Theory of Relativity brings out the fact of continuity underlying the cosmic mechanism, and running through all cosmic events, the quantum phenomena indicate discontinuity.

These puzzling facts can be easily woven into a highly mystifying world picture in support of the contention that new physics has completely outmoded the naive notions of the past, repudiated the crude, mechanistic, determinist, materialist doctrines, and cleared the ground for a mystic view of the world—for the resurrection of religion on a scientific basis.

There is, however, nothing so very new in new physics. If we look at the world of new physics closely, we find old friends in

new guise. Of course, the new physical theories represent a tremendous advance upon the theories of classical physics. In that sense, they are certainly new. Our knowledge of the world, macrocosmically as well as microcosmically, has grown amazingly in consequence of the discoveries made during the last half a century of physical research. But new theories are only a continuation of old theories; they are constructed on the basis of the latter. They are not mutually exclusive. Old theories are not discarded as wrong. In the light of new data, accumulated in course of the investigation carried on in accordance with the old theories, they have been amended, modified, refined, elaborated.

Deprecating the fashion of talking that the theories of classical physics have been found wrong by more modern physical research, Professor Frederick Soddy writes:

"There is a certain quality of permanence about experimental scientific discoveries, which is not always believed. An important addition to experimental knowledge, whether made in the time of Robert Boyle or yesterday, is never displaced. Points of view may change; theries interpreting and explaining experimental knowledge may have their periods of adolescence,

maturity and decline; but the framework of the structure, the experimental facts around which ideas are arranged, is too well and truly laid to fear demolition. Even when, as in the present day, the foundations of science are shifted to an ever deeper and more fundamental place, the experimental basis of facts is unthreatened. The idea that the whole edifice of chemical science was tottering to its fall as the result of the discovery of the intra-atomic change of radio elements, is one that has always been too absurd to call for reply."

Again: "There is sometimes loose talk —even among scientific men, attempting to generalise concerning other subjects than those in which they have won their position —that the scientific hypotheses of one age become the laughing stock of the next. But such talks are often the laughing stock of their own age to those best qualified to form an opinion." ("Science and Life").

The Theory of Relativity and the Quantum Theory constitute new physics. Generally speaking, the former covers microscopic entities, events and relations. Of the two, definite philosophical inferences can be at present made only from the Theory of Relativity, which is practically rounded up as a logically self-contained system. The

Quantum Theory is still in a state of flux. Facts covered by it are not yet fully systematised in such a way as would offer a reliable ground for philosophical deductions which could have more than a tentative value. The "revolutionary" features of new physics belong to the sphere of the Quantum Theory. They are features of the sub-atomic world. Having pushed its investigation into regions, unknown previously, physics has discovered new and strange facts, facts that do not readily fit into the old theoretical structure. On the basis of the newly discovered facts, as soon as they are established as ontological facts, and are completely systematised, new theories will have to be developed. But they will not replace the old theories; they will only supplement the latter. Both together will compose the entire body of physical knowledge.

Laws of science are never absolute. Their objective validity lies in their approximation to the laws of nature. The laws formulated by new physics do not prove that the laws of classical physics were false. These are true as far as they go. The new laws go farther. They represent a closer approximation to the laws of nature.

Scientifically, the fundamental achievement of the Theory of Relativity is the re-

conciliation between gravitation and electro-magnetism. The reconciliation represents a grand synthesis of the vast body of knowledge about nature, acquired step by step, through observation and experiments, during three hundred years, ever since the days of Galileo. The way towards this reconciliation was prepared by the accumulated result of theoretical as well as experimental researches, conducted on the basis of a set of hypotheses which constituted the foundation of classical physics. In course of those researches, facts were found and ideas crystallised, which could not be satisfactorily explained and fitted into the theoretical structure of classical physics. The explanation is supplied through the introduction of the principle of Relativity.

The discord between Newtonian dynamics and the laws of electro-magnetic propagation of energy, as stated in Maxwell's equations, is removed by discarding some of the hypothetical categories of classical physics. **A priori** assumptions or postulates are abandoned when, in the light of **a posteriori** knowledge, they appear to be unnecessary, even if in the past, they provided a point of departure for fruitful research, or filled up gaps in the knowledge of nature. Gravitational force and ether, for example,

were such stop-gap hypothetical categories. As soon as the gaps disappeared, in course of the advance of our knowledge, physics could do without them. The discord between the two main bodies of classical theories—Newtonian Mechanics and electro-magnetism—which together explained practically all observed phenomena, was largely due to their respective hypotheses, namely, gravitational force and ether. The one implies action at a distance, while the other postulates a continuous medium.

With the Theory of Relativity, physics has been able to throw off the ballast of unnecessary hypotheses. Consequently, the entire body of physical theories has been coordinated into a harmonious whole, representing a higher level of knowledge, a closer approximation to the objective truths of nature.

As regards the hypothesis of the gravitational force, the way to its final rejection by Einstein was prepared by the theoretical works of Kirchoff and Mach. Kirchoff was a classical physicist. Mach, by virtue of his purely negative criticism of Newtonian dynamics, stood on the border-line between the old and new physics. The two together developed a theory of machanics which dispensed with the category of force as conceiv-

ed by Newton. Their theory was elaborated and perfected by Hertz, also a classicist—the last of the Mohicans, so to say,—in a way which directly led to the result that there is only one law of motion, which strikingly approximates Einstein's Kinematics, according to which every physical system moves in a geodesics. It has been pointed out by Bertrand Russell that, "although the whole of this development involved no essential departure from Newton, it paved the way for the Relativity Dynamics." In other words, there is a continuity between classical physics and the Theory of Relativity. Indeed, Russell goes so far as to make the following declaration, which lays even a greater stress upon the fact of continuity underlying the entire history of the development of modern physical science, and consequently of natural philosophy.

He writes: "And now that the theory is fairly complete, one can see that, theoretically, it ought to have been discovered by Galileo, or at any rate as soon as the velocity of light became known. It represents a technique, a better philosophy than that of Newton; indeed, one of its most remarkable feature is the adaptation of the technique to philosophy." ("The Analysis of Matter.")

The Theory of Relativity, thus is the

logical outcome of classical physics; the whole store of experimental data and theoretical knowledge, acquired since the days of Galileo, has gone into its making. Philosophically, it represents an improvement of the mechanistic cosmology of Newton, not a repudiation. Bertrand Russell maintains that materialist philosophy has received a severe blow from the Theory of Relativity. If, philosophically, it is simply "better" than Newton's philosophy of nature, as Russell himself correctly states in the passage quoted above, the difference is only quantitative, not qualitative. Philosophically, the Theory of Relativity does not repudiate materialist natural philosophy in favour of idealism or any other school of philosophy antagonistic to materialism. It frees materialism of some vulnerable features, and establishes materialist philosophy upon a firmer foundation of empirically acquired physical knowledge. That is the obvious meaning of Russell's statement, and it contradicts the fashionable thesis that the philosophical implication of new physics is the rejection of materialism.

Philosophically, the Theory of Relativity is better than Newton's philosophy of nature, because it does not require the a priori elements postulated by the latter, which

supplied the opponents of materialism with the butt of their attack. Newtonian cosmology, though mechanistic, made room for a super-natural agency, so long as the nature of gravitational force remained a mystery. The Theory of Relativity has solved this mystery. Einstein's Kinematics does not require force in addition to matter. No place is left for the hand of God.

Einstein has improved Newton's philosophy by the "adaptation of technique to philosophy". What does that mean? It means that the cosmology represented by the Theory of Relativity is strictly empirical, mathematically deduced from experimental data. It is entirely free from the speculative elements—the metaphysical features which entered into Newtonian natural philosophy. The Theory of Relativity shows that a mechanistic view of the Universe results from the technique of physical observation, measurement, and general principles deduced through rigorous mathematical analysis of the strictly verified data thus obtained.

Practically all the experimental data and mathematical technique, which went into the making of the Theory of Relativity, were collected and developed, over a whole period of research, conducted by a series of physicists and mathematicians on the basis

of the hypotheses of classical physics, before Einstein combined the two sets of results (experimental data and mathematical technique) fruitfully into a co-ordinated, logically self-contained, system of physical knowledge of decisive philosophical significance. The rejection of the hypothesis of a continuous medium (ether) and the revolution in the concept of space and time were inherent in the negative result of Michelson-Morley experiments to measure absolute velocity through space. That famous experiment was made already in the eighties of the last century. Efforts made to explain the negative result of that experiment, particularly those of Fitzgerald, Larmor and Lorentz, directly led up to the birth of the Theory of Relativity. All those fore-runners of this theory were classicists.

The revolution is essentially philosophical, particularly, in the epistemological sense. The philosophy affected by the revolution is not the philosophy of nature, closely associated with classical physics, and developed into a quasi-materialist mechanistic conception of the Universe in the eighteenth and nineteenth centuries. On the contrary, it deals the final blow to classical idealism, by liquidating the absolutist conceptions of space, time, matter, motion and force. The

Theory of Relativity frees mechanistic philosophy of nature from its flaws and fallacies, which were, and still are, seized upon for setting up all sorts of veiled idealism. It makes a great contribution to the victory of materialism. The philosophical outcome of the Theory of Relativity is bound to be positive, because, as a system of physical theories, it is not antithetical to, but stands in the relation of continuity with, classical physical ideas.

These changes in the conceptual scheme of scientific thought are exactly of the kind demanded by philosophical criticism of the metaphysical foundations of classical physics. Broad writes: "I hope to be able to show that these modifications, which are forced on us as philosophers when we begin to deal with the concept of matter, are of somewhat the same kind as those which the physicists have had to make for purely domestic reasons. If this can be shown even in rough outlines, it will greatly strengthen the case for the newer views of space, time, motion and matter. There is much in these views which is at the first sight highly paradoxical and upsetting to common sense, so that it is of some advantage even to the scientist to know that they can be justified on other grounds than the special needs of

his science. On the other hand, it is always a comfort to the philosopher to know that he is not simply **bombinans in vacuo,** but is working on lines which have been found to lead to useful results in some concrete region of science." ("Scientific Thought").

It was the function of philosophy to define the nature of the concepts and categories, the functions and relations of which were the object of scientific research. As a result of this division of labour, philosophy, on the one hand, bungled its function, because the task it undertook could not be accomplished before science had created the necessary conditions. Only in the revealing light of empirically acquired knowledge of nature, could such metaphysical concepts as space, time, force etc. be defined; in other words, the physical content of such **à priori** common sense concepts could also be discovered. On the other hand, it was tacitly admitted by science that there was a limit to the reach of its investigations. But in course of time, science transcended that limit. In search of the laws of nature, it pushed its investigation beyond the functions and relations of the basic physical entities. The intrinsic character of these entities, their internal structure also became objects of scientific research. Thus, science,

in course of its development, encroached upon the preserves of philosophy, and attcked the problems which the latter had so woefully failed to solve.

The philosophical significance of new physics lies in the fact that it brings problems, hitherto considered to be metaphysical, within the compass of physical research. Such basic concepts as space, time, matter, causality etc. are no longer objects of speculative thought. Exact knowledge about their intrinsic nature and inner structure is being acquired through observation and experiment.

For ages, philosophy speculated vainly about the nature of time and space. Examining the traditional metaphysical concepts in the light of experience and experimental data, the Theory of Relativity discovers their ontological content. It shows that space and time are not metaphysical categories; that they do not precede matter; that, on the contrary, the concepts of space and time result from our experience of the being and becoming of matter. According to speculative philosophy, space is the receptacle of matter. Newton took over this metaphysical concept of space, and introduced it into classical physics. Einstein has shown that empty space is a meaningless, in-

conceivable, concept; that space exists because material objects exist—as the distance between any two of them. Similarly, there is no absolute time which flows in a metaphysical void. The concept of time results from the physical fact of becoming. It is the interval between two events, that is, changes in any given object.

The task of attacking problems regarding the internal structure of matter has fallen to the really new science of atomic physics which is governed by the Quantum Theory. For classical physics, matter was composed of atoms, which were supposed to have no internal structure. New physics has not only analysed (and actually broken up) atoms into protons and electons, but has ascertained the quantitative value of these newly discovered units of the physical world. Investigation is pushed still farther as regards the internal structure of these units themselves. In consequence of that investigation, the old philosophical concept of substance is shedding its metaphysical character, and is appearing as something accessible to experience; that is, as a physical category which can be measured mathematically. All forms of radiation have been traced down to electric action; and electricity has been found out to be composed of

material particles. The newly acquired knowledge about the structure of matter has settled the old controversy between the pluralist and unitarian views of substance, conceived as a metaphysical category. New physics had discovered substance to be all-pervading as well as corpuscular.

The distinctive character of the new physical theories, and the philosophical significance thereof are clearly indicated in the following quotation from Heisenberg. "With the advent of the Theory of Relativity, it was necessary for the first time to recognise that the physical world differed from the ideal world conceived in terms of every day experience. The experimental material, resulting from the modern refinement in experimental technique, necessitated the revision of the old ideas, and the acquirement of new ones, but as the mind is always slow to adjust itself to an extended range of experience and concepts, the Theory of Relaitvity seemed at first repellantly abstract. Nonetheless, the simplicity of the solution for a vexatious problem has gained it universal acceptance. To mould our thought and language, to agree with the observed facts of atomic physics, is a very difficult task. In the case of the Theory of Relativity, it proved advantageous to return to the older philo-

sophical discussion of the problems of space and time. In the same way, it is now profitable to review the fundamental discussion, so important for epistemology, of separating the subjective and the objective aspects of the world. Many of the abstractions, that are characteristic of modern theoretical physics, are to be found discussed in the philosophy of past centuries. At that time, these abstractions could be disregarded as mental exercises by those scientists, whose concern was with reality; but to-day we are compelled by the refinement of experimental art to consider them seriously." ("The Physical Principles of the Quantum Theory").

The boundary line between science and philosophy can no longer be maintained. Physical research is no longer limited by the formalist view of reality. It has become concerned with the nature of reality—a subject formerly left to philosophy to be treated speculatively. Therefore, problems, for centuries discussed drearily by philosophy, are being tackled and gradually solved by the scientific method of observation and experiment. The refinement of experimental technique has brought within the compass of physical research such categories as were formerly considered to be metaphysical, and as such subjects of pure thought, that is,

speculation. The **a priori** concepts of such categories must necessarily change so as to correspond with the exact knowledge about them, which has been acquired through the empirical method of observation and experiment. The Theary of Relativity has been able to give a simple solution for the vexatious problem of time and space, because modern physical research, with its refined experimental technique, has revealed the nature of these "metaphysical" categories, discovered the content of these concepts. Conceived as absolute metaphysical categories, independent of, and antecedent to, all physical phenomena, time and space naturally presented baffling problems. But the problems ceased to be baffling as soon as, in the light of observed facts and experimental data, it was realised that time and space, as elements of the physical world, did not possess that absoluteness associated with them as ideal metaphysical categories. All mystery about space and time disappeared in consequence of the discovery that they enter into our experience only as relative entities. Their absoluteness is indeed—an empty concept. Mysticism results from the attempt to define the absolute. Because, the absolute, if it is really absolute, must be indefinable. Any definition of the indefinable is bound to be

clouded in mystery, couched in enigmatic terms, as all the classical philosophical definitions of space and time are. We can define only what we know. Exact knowledge is derived through observation and experiment. Spatial and temporal phenomena can be observed and measured only as relative entities —in their relation to matter. The Theory of Relativity solves the vexatious problem of time and space by exposing the meaninglessness of the absolutist, ideal, concepts of these categories. It dispels all mystery about them by showing that, as a realisable reality, they cannot be independent of, and antecedent to, the physical being, but are properties thereof and therefore can be defined, measured, realised, in relation to the movements of, and changes in, physical objects.

But it is shocking for human mind to be jolted out of a traditional mode of thought. Illusions cannot persist, unless they are taken for reality. Once taken for reality, illusions disregard experience. The absolutist notion of space and time is so deeply embedded in human mind that it cannot be easily eradicated. For the average mortal, it is rather an article of faith than a philosophical concept. Hence the extreme difficulty of visualising space and time as they are really discovered to be through system-

atic observation and refined experiment.

New physical theories, therefore, are not mystifying. On the contrary, they throw new flashes of light on the truths of nature; but new flashes naturally dazzle our eyes in the beginning. We are loath to give up ideal notions for the concrete realities of experience. The revolutionary significance of new physics is that it compels us to change **a priori** metaphysical concepts in accordance with experienced facts. The Theory of Relativity is more than a theory of physics, in the technical sense. It is a cosmological conception, built on the solid basis of the total store of physical knowledge accumulated during the last three hundred years of scientific research. Consequently, its epistemological significance is very far-reaching. It is a comprehensive system of philosophy not a closed system of speculative thought, but a harmonious explanation of all observed natural phenomena in the light of empirical knowledge.

It is more difficult to mould our thought and language in accordance with the discoveries of atomic physics, because they concern entirely new, previously unsuspected, phases of the physical world. The Theory of Relativity is the culmination of a whole period of physical research. The Quantum

Theory, on the contrary, opens up a new field of physical investigation. Classical physics studied the diverse phenomena of nature with the object of discovering general laws governing them. It took matter for granted. Matter and energy were the fundamental hypotheses of classical physics; its elementary indefinables, so to say. The internal structure of these basic categories is the subject of the present day physical research. The metaphysical concept of substance has been thrown in the melting pot. The conception of matter has to be adjusted to the exact knowledge about the structure of the basic units of the physical world. Philosophers disputed about the nature of substance. Some, led by Descartes, held it to be all-pervading; others favoured the corpuscular conception expressed in Leibniz's theory of Monad. Atomic physics is well on the way to settle the old controversy of speculative philosophy; and it promises to reconcile both the views of substance. Because, the basic units of the physical world have been discovered to possess the property of waves as well as of particles.

Naturally, it is extremely difficult to grasp this new conception of substance, which absorbs matter and energy into a dynamic, unitary, primordial, physical being,

constituting the background of all the phenomena of nature. It is extremely difficult, because it cannot be conceived in terms of every day experience. The conception is highly abstract, and can be expressed only in obscure mathematical language. Hence the theories of atomic physics appear to be mental constructions. But they are derived from observation and experiment, just as any other scientific theory.

Here we are up against the old problem of philosophy—the problem of perception. The theories of new physics are not derived from direct perception. But the experimental verification of these theories of so very abstract nature, proves that they do represent knowledge of objective physical realities. On the other hand, any abstraction contains a large subjective element. Thus, physical research is leading to a point where the line of demarcation between the subjective and the objective disappears. If it is empirically discovered that, in the long run, the subjective cannot be differentiated from the objective, the most puzzling problem of philosophy, namely, the epistemological problem, will be solved. Modern physical research is leading us to the realisation of the fact that external world is a misnomer. We are integral parts of the world

of our experience. We do not watch the world as outsiders. Our consciousness, our ego, our reason—all these subjective categories are inseparably interwoven in the texture of the so-called external world. These subjective constituents of nature are parts of the whole complex of the objective physical world. They grow out of the background of the physical world, and therefore can serve as the instruments for acquiring knowledge about it. If mind was essentially different from matter, there could be no possible contact between the two, and knowledge would be impossible. Biological sciences have led us to the realisation of this basic fact of materialist monism. Now physical research is reaching the same point from the other side—through the analysis of the inner structure of the basic units of nature.

CHAPTER V

SPACE AND TIME

The discoveries of Quantum Physics are supposed to have made the sensational revelation that the foundation of the physical world is not material, and that there is no causal connection between physical events. Without substance and causality, science cannot do anything. Therefore, physics seems to have built a world out of nothing. Has it really been deluding the world all this time? An examination of the results of physical research in the microcosmic world shows that the position is not so disconcerting.

Before proceeding to that examination, it will be useful to dwell a little longer on the iconoclastic achievements of the Theory of Relativity. Moreover, I am of the opinion that the physical principle of Relativity may turn out to be the key to all the secrets of nature, and as such may indicate an approach also to the problems of subatomic physics, which, for the moment, appear to be insoluble.

All the iconoclastic ideas, which are

supposed to have pulled down the beautiful structure of classical physics, are developments of the following simple statement of observed facts: **All motions are relative; bodies move relatively to one another; the speed of a body is measured in relation to another, which is supposed to be at rest; but there are no bodies in absolute rest.** It is easy to see what an entirely different light is thrown on the concepts of time and space by this new discovery. Movement makes the idea of time conceivable. If movements are relative, time cannot be absolute. On the other hand, time and space are co-related concepts. The revolution in one cannot leave the other unaffected.

But it was really not a revolution. Newton himself was aware of the fact that there are no bodies in absolute rest. He actually wrote: "It is possible that, in the remote regions of the fixed stars, or perhaps far beyond them, there may be some body absolutely at rest, but it is impossible to know, from the position of bodies to one another in our region, whether any of these do keep the same position to that remote body." Then he made the statement that "absolute rest cannot be determined from the position of bodies in our region."

It is clear from this that the dynamic

view of the Universe, represented by the Theory of Relativity, would not flabbergast Newton, if he came back to life to-day. Because, he would see that since his time, following the trail blazed by himself, science has explored the farthest regions of the heaven, and found no body at absolute rest.

The impossibility of finding some body at absolute rest implies the impossibility to measure absolute velocity. The disappearance of absolute time is logically inevitable.

The Theory of Relativity is based on a conclusion drawn from the negative result of experiments to find a way of measuring the absolute velocity of bodies through space. It explains the negative result. It should be noticed that neither Newton nor Einstein denies the existence of absolute velocity; both find that it is impossible to discover it. The philosophical implication is epistemological, not ontological.

Newtonian dynamics, notwithstanding its absolute space and time, does not offer any standard for measuring absolute velocity. Newton had rejected the Cartesian concept of all-pervading substance. His system was built on the molecular conception of matter. Matter-in-motion was its basic postulate. The two simple laws of motion occupy the central place in Newtonian mecha-

nics. The entire system does not know of anything at absolute rest. Thus, relativity of motion is inherent in the Newtonian system. But the metaphysical notion of the absolute dominated thought, not only philosophical, but even scientific. (Newton personally was full of theological prejudices.) Therefore, the logical conclusions of his cosmological idea could not be clearly and consistently thought out. Physics had to go through a whole period of development, acquiring empirical evidence against the metaphysical absolutist view, before the relativist implication of Newtonian dynamics could become evident in the light of a greater, more concrete, knowledge of nature.

The idea of motion results from the change of distance between two bodies. I consider somebody moving away from me, when the distance between us increases. But the other person also has exactly the same experience as entitles him to conclude that I am moving and he is at rest. Since the idea of motion results from the increase of an intervening distance, and the other person also experiences the distance between us increasing, it will be perfectly legitimate for him to consider himself at rest, and me moving away. Such an assertion made by him cannot be refuted logically.

In the absence of any body at absolute rest, absolute velocity can never be measured. Motion is always relative; and the concept of motion being inseparably associated with the idea of distance, distance must also be regarded in the light of relativity. The discovery that motion and distance are always relative called for a revolution in the concept of space and time. Because, these metaphysical categories enter our experience, and become objects of physical measurement, only in the tangible form of distance and motion. The Theory of Relativity solved all the problems raised by the negative result of the Michelson Morley experiment by introducing a new way of regarding space and time, showing that these are not independent entities, as conceived previously, but are woven inextricably in a background on which all physical phenomena occur. Philosophically, the fundamental achievement of the Theory of Relativity is to have brought about this revolution in the concepts of space and time.

Having revealed the imaginary nature of absolute time, and consequently of absolute space, the Theory of Relativity merges space and time into a four-dimensional continuum. The novel conception of Space-Time, apparently a combination of two

qualitatively different entities, has naturally been very puzzling. It could be understood, however, from two points of view: geometrical and philosophical. But it can also be understood as a simple commonsense proposition. Here is the picture as presented by Sir James Jeans:

"If we are to study objective nature, we clearly need an objective framework, which shall be independent of the motion of our particular rocket through space. It is nothing more nor less than a four-dimensional space—the ordinary every day space of any individual, extended by the addition of a fourth dimension—the ordinary time of the same individual. When each man combines the space he has chosen with the corresponding time, the four-dimensional space he obtains will always be the same." ("The Background of Modern Science").

Our experience of time is dependent on the changes in the external and internal relations of a body; therefore, the inter-dependence of time and space is an empirical fact. They are not welded together arbitrarily, as a mathematical device are welded together in n regard them as independent the sense that either of them can exist itself, is a mathematical abst

space and time are always found mixed up together, whenever they enter our experience, to regard them as independent categories is obviously an arbitrary procedure. The question is: How do these apparently distinct categories get so inextricably interwoven? Relativity physics answers the question, thus helping the solution of a problem which puzzled philosophy for ages.

Space and time are not categorical entities nor ultimate realities. They derive their very existence from a common source, which is ontologically antecedent to them both. They are functions of the physical existence. Hence, though apparently so very different, they are always inextricably mixed up, except in abstraction. Fundamentally, they represent the self-same physical reality —extension or extendedness of matter, geometrical and chronological, respectively. Space is the geometrical extension of matter, and time is its chronological extension.

It is difficult to grasp this new idea simply because our minds are habituated to move in an old rut. A little reflection is necessary to realise the remarkable simplicity and logical soundness of the new conception of Space-Time. Indeed, it is very surprising that, throughout the ages, philo-

sophers should have managed to mystify something so obvious. Space was postulated as the receptacle of things, because the latter must be somewhere. The primitive logic of naive commonsense made location antecedent to existence. Speculative philosophy could never outgrow the primitive logic of its infancy. But the fallacy is obvious.

If things must exist somewhere, space itself must also have a location. Otherwise, it cannot exist. Thus, the idea that existence is dependent on location leads to **regresso ad infinitum.** According to the very traditional definition of existence, space does not exist except as extension; but extension logically presupposes something extended. This idea about the structure of space is implicit in Euclidean geometry itself. A line is not the integration of the bits of space separating points, but of the points themselves; and a plane is the sum total of a number of lines. Consequently, space is constructed of points; it is the product of existence. The function of the point is to exist; existence, therefore, is antecedent to space.

The analysis is equally applicable to the concept of time. Duration also is conditional upon existence. The logic is self-evident. A thing must be, in order to become. The idea of time is born of the primitive experience of

interval between events, which are changes in existence. Becoming is a string of events, constituting the life-history of a thing. Space is being, and time is becoming. While pure being is logically conceivable, becoming always involves being. Thus, time can never exist independent of space. Nature has welded it together with space.

This simple analysis of the commonsense idea of space and time leads directly to the picture of a four-dimensional continuum. Being is three-dimensional. But the world is a process of becoming. Pure being, that is, eventless existence, is an abstraction. Becoming is four-dimensional, because it embraces existence and change—space and time. A process of becoming is a four-dimensional continuum. The world picture presented by the Theory of Relativity is a matter of commonsense and elementary logic. The traditional concepts of space and time were artificial and illogical. The march of knowledge has left them behind.

There is no paradox in the fact that our present knowledge of nature differs from that of the past. Any mental or physical picture of an object seen in a dim distance is discovered to be defective, in some respects erroneous, when it is regarded from a

more advantageous position. The discrepancy between the defective and the more accurate picture of the object does not disprove the fact that both of them represent something that exists independent of the observer. It results from the conditions under which the object is observed. The variation of knowledge does not affect the uniformity of the object of knowledge.

Columbus discovered America, and described it on his return. But other explorers who followed him found the New World more and more different. Columbus even did not know that he had discovered a new world. He believed to have reached India by a new route. Gradually, it was realised that a new world had been discovered, and the description of the New World became fuller and fuller as more and more visitors went there, and saw more and more of it from various sides. The discrepancy between the report of Columbus and those made by subsequent visitors, also the divergence of the reports made by these latter, however, did not affect the fact that in every case the self-same New World was described. America existed by itself. Its existence was not conditional upon the mind of a Columbus who discovered it. The divergent descriptions were of America; they were not fabri-

cations of the minds of visitors. They depicted different pictures, because they saw diverse aspects of the self-same country. What was discovered by Columbus was not the whole of America. His description of America covered only the coast-line of an island near the vast continent which was still to be discovered. It took nearly two-hundred years before the New World could be generally described, geographically. Even to-day, a physical description of the continent of America must be far from complete. Its total mineral wealth is still to be estimated. Columbus went in search of spices. Cortez opened up a rich source of silver. Coal and petroleum followed. Now vast deposits of radium have been discovered in the Arctic regions of Canada. The New World as we know it to-day is vastly different from the America discovered by Columbus. Yet, it is the self-same physical entity. The object of our knowledge is the same. But our knowledge of it has gone on increasing, the more we have investigated it.

The analogy roughly applies to our knowledge of the physical world. There is no discrepancy between classical physical theories and the theories of New Physics; they represent two different stages of the knowledge of nature, which yields more and

more of her secret the further we push our investigation. The apparent paradox disappears as soon as we get rid of the prejudice that, to be correct, knowledge must be perfect—absolute. The basic significance of the Theory of Relativity is that it helps us to get rid of the venerable prejudice, not through pure reason, but with the aid of experience.

CHAPTER VI

SUBSTANCE AND CAUSALITY

It is also not true that new physics, as represented by the Quantum Theory, has discarded the notion of substance. As a matter of fact, philosophically, it completes a task begun by the Theory of Relativity. It abolishes the notion of absoluteness regarding the remaining two categories, namely, substance and causality.

The Theory of Relativity reduces the entire cosmic scheme, including space, time, mass, motion, force, energy—to one single category. The ultimate units of that fundamental reality are conceived as "events", instead of mass-points, in order to lay emphasis on its dynamic character. The world is not a static being; it is a process of becoming. Therefore, it should be interpreted in terms of "events", that is, of changes in the state of its ultimate constituents. Only that way can we get a realistic picture of the cosmic scheme. Because "events" are dynamic physical magnitudes, intervals between them are spatial as well as temporal.

So long as physics and philosophy believed in absolute space and time, regarded these as ultimate categories, logically antecedent to being and becoming, the criterion for the reality of matter was simple location in space. Matter was conceived as minute particles of mass occupying discrete positions in space, at given moments of time. Atomic physics has discovered that matter does not possess those properties—always in the absolute sense. The notion of simple location in space must be abandoned. From this, it is inferred by some philosophically minded scientists that the old concept of substance must be discarded: matter does not exist physically, because its ultimate units are not extended in space. That conclusion is inevitable if we hold on to the idea that existence is extension in space. The revolution in the concept of space, brought about by the Theory of Relativity compels rejection of the old definition of existence. Matter does not exist in space. On the contrary, space is a function of matter.

Sub-atomic research has disclosed that matter is not constructed as classical physics hypothetically pictured it to be. The world of new physics is constructed out of a substance, in which the difference between gross matter (particles with spatio-temporal con-

tinuity) and energy disappears. The Theory of Relativity indicates mathematically that mass and energy are mutually convertible. That possibility was deduced from observed facts. Thus, the way to the abolition of dualism has been discovered. Matter has been found to be of electric nature; on the other hand, it has been discovered that electricity is composed of material particles.

The new knowledge about the substratum of the world does not imply a denial of the reality of matter. The problem raised is about the structure of the ultimate substance. The concept of substance is affected by the revolution, in so far as it was identified with mass. Mass is a property of matter; but it is variable like all other properties. The absoluteness of mass disappears already in the Theory of Relativity. Energy is a form of matter, and matter is a vibratory substance. Atomic physics has reduced matter to energy. That does not mean a denial of matter. No Quantum Physicist would deny the existence of atom or its constituents—electrons and protons. The revelation is that even electrons and protons are not the ultimate units of matter. But they are measurable entities, and no serious scientist maintains that measurable entities can emerge out of nothing.

Only a generation ago, physical reality of the atom was disputed. There was a "crisis" in physics at the turning of the century. That is an old story now. Atom has survived Mach's attack. To-day, electron has become the object of doubt. But atoms are composed of protons and electrons. If these latter are not material entities, the doubt about the physical reality of the atom will raise its head, and the whole magnificent system of atomic physics will look ridiculous —much ado about nothing. The "metaphysical" concept of substance remains the basis of physics. Only, it is no longer an **a priori** concept—of a hypothetical category. The present theory about the nature of the stuff of the world is based upon empirical knowledge. It is **a posteriori** established. The new conception of matter is only a refinement of the old conception.

The position has been depicted as follows by Professor Andrade of Cambridge:

"The older conception of atom was good enough to explain the phenomena then considered, and we can still use it for certain simple problems; but to explain the facts of radio-activity and of spectroscopy, we must introduce the newer features of the theory. The new theory is also better than the old, because it demands only two ultimate things

from which atoms are supposed to be built up. The fewer entities we need to assume as fundamental, in order to explain things, the better our theory. We do not claim any finality for it: some new discovery may suddenly force us to modify our idea in many particulars, but the success of the present theory shows that we shall probably have to retain many of the general features of the theory. It is an excellent working hypothesis, because it has shown us law where law was not hitherto discovered, and connection between different phenomena, where before we knew no connection. It has enabled us to arrange our known facts in a more convenient and logical way, and has led to the discovery of very interesting new facts. It is justified by its worth, but is not final. Science is a living thing, and living things develop." ("The Mechanism of Nature").

Thus, the revolution in the concept of matter, brought about by the discoveries of Quantum Physics, does not mean that all established physical theories are upset, with the consequent downfall of the mechanistic-materialist philosophical notions associated with classical physics. The impending process is towards a higher synthesis of ideas. Matter is not an inert mass moved by a mysterious force. Matter and energy are the dual

manifestations of substance, which enters our experience as these manifested forms. Being realises itself in becoming.

Clearly, physics is reverting to the idea of cosmic continuity, apparently disturbed by the discovery of Quantum phenomena. Continuity, assumed by classical physics, does not exist as pictured in Newtonian dynamics or by Maxwell's equations of electromagnetism. Quantum phenomena prove it. But wave-mechanics—the prodigious progeny of the Quantum Theory—depicts continuity on a higher level. Wave-mechanics indicates the way to a final systematisation of our knowledge of the sub-atomic world into a theoretical system, in harmony with the other branch of new physics, namely, the Theory of Relativity.

Indeed, a rational explanation of the Quantum phenomena can be found only in an application of the physical principle of Relativity to the study of microcosmic events. Wave-mechanics represents that application. It is heading towards the point where the two aspects of the world of new physics meet, and merge into each other. Eddington, of all, has confidently drawn this conclusion from the highly abstract mathematical researches of Dirac, one of the ablest of Quantum physicists.

At the end of the last century, it was discovered that atom was not the smallest particle of matter, as it had been assumed to be ever since the days of Dalton. It was discovered that an atom consisted of a nucleus, charged with positive electricity, and one or more negatively charged particles distributed around the nucleus. The negatively charged particles were called electrons. This theory, tentatively suggested by Professor Thompson of Cambridge, was substantiated during the following years by the discovery of radium, and the study of the phenomenon of radio-activity. That was the beginning of atomic physics.

A more accurate picture of the inside of the atom was presented to the world by Rutherford in 1911. His theory, subsequently elaborated by the famous Danish physicist Niels Bohr, is as follows: The inside of an atom is like a minature solar system. The positively charged nucleus—proton—is situated in the centre, the electrons moving around it like the planets around the sun. Practically the entire mass of the atom is concentrated in the proton. Only a very tiny fraction of it is distributed among the electrons. Yet, in size, the electrons are thousand times larger than the protons, and move

at a terrific speed, sometimes nearly approaching the velocity of light.

The almost imperceptible mass, coupled with a prodigious speed, in the beginning, made the impression that the electron was not a particle of matter. The impression produced "the crisis of physical theories" at the turning of the century. There was much talk about "dematerialisation of matter". But the impression was altogether unfounded, because Thompson himself had estimated the mass of an electron.

The incredibly small magnitudes of atomic physics are not the result of only abstract mathematical calculations. They have been verified experimentally. The fact of fundamental importance, which emerges from the biography of the electron, is that there is nothing immaterial about it. Harvey-Gibson writes: "The relatively massive proton has been identified with the smallest known unit of positive electricity, and the light electron has similarly been shown to be the smallest unit of negative electricity. Yet, each are particles of matter, in the sense that they possess mass, and are subject to gravitation, and so, in its last analysis, matter is indistinguishable from electricity." ("Two Thousand Years of Science").

An electric current is a stream of elec-

trons. This fact represents a great positive achievement of atomic physics. It conclusively settles an age-long, fundamental question of philosophy. Reduced to the unitary element of electricity, the materialness of the Universe does not disappear into mystic nothingness. Because, electricity is a thing: it exists physically.

If we are to look for the ultimate unit of "pure" matter (in the gross sense of the term), there is the neutron. Nature, after all, is not so niggardly as Eddington accuses her to be. She does not keep her secrets hidden in unfathomable mystery, so that man may never discover them. Whoever earnestly search for them are rewarded with real knowledge.

The inner core of the atomic nucleus is made up of neutrons, while the active protons form the outer shell. Then, there are the free electrons, moving in space around the nucleus. The ninety-two hitherto known chemical elements are combinations of their respective types of atoms varying in bulk and complexity. This large collection of microcosmic solar systems presents atomic physics with a problem which appears to defy human ingenuity. To sort them out so as to establish some general principle of atomic mechanism was, of course, the first pro-

blem. Niels Bohr attacked the problem, and produced a plausible solution by 1913.

He described the inner mechanism of atom roughly as follows: Each free electron in an atom can move alternately in many orbits—circular or elliptical. But the number of these possible alternative orbits is definite in the case of each electron. When the normal condition of any atom is disturbed through the rise of temperature, the free electrons jump to higher and higher orbits, that is, to orbits farther and farther away from the nucleus. Conversely, the process of cooling down is marked by the fall of the electron to successively lower orbits. The motion of the electrons in their alternative orbits accords with the classical law of electro-dynamics. But the classical law cannot explain the jump from one orbit to another—upwards and downwards. Thus, there arose a new problem. There appeared to be a rift in the whole system of physical theories; the laws of atomic mechanism do not fully coordinate with the classical principle of electro-dynamics, governing the entire physical Universe. In this rift lies the root of the so-called new physics, which, with its principle of Uncertainty or Indeterminacy, set the scientific world agog.

The inside of an atom is not a subject

of direct observation. Our knowledge of it is inferential. The inferences, however, are made from clear and accurate data gathered through spectrum analysis. In the hypothetical structure of Bohr's atom, the electron is a particle. Yet, the fact that it monopolised a whole series of orbits contained a clue indicating its real structure. It is a particle, and nevertheless somehow spreads over a whole orbit. A pure, honest, particle need not be so exclusive. If the electron was a pure particle, there would be nothing to prevent more than one from moving in the same path. Refined spectrum analysis revealed the fact that, while in the upper orbits the electron behaved like a particle with a definite mass, moving strictly according to the classical electrodynamic law, only jumping unconventionally, from time to time, the definiteness disappears in proportion as it falls to lower orbits, nearer the nucleus. The electron undergoes a metamorphosis from a particle, with a series of definite positions, to a sort of a line, the points composing which cannot be singled out.

The clue offered by the breakdown of Bohr's hypothesis is that in the lower orbits the electron does not behave like a particle. Following up this clue, De Broglie and

Schroedinger advanced the theory of wave-mechanics, according to which the electron in the lower orbits is not a particle of matter with definite positions in space. The discovery that the ultimate constituent of matter does not have simple location in space, together with its corollary that therefore the speed of its motion cannot be measured in terms of time, is taken for the foundation of the opinion that physics has broken away from the principle of determinism, and has revealed the metaphysical origin of the physical world.

The foundation, however, is altogether imaginary. De Broglie showed that light simultaneously possessed the properties both of particles and waves. This was established theoretically, by mathematical analysis, as well as through experimental observation. The general principle to be derived from the new theory of light evidently is that physical properties, which were previously to be considered as mutually exclusive, are really associated throughout the Universe. The trail to this synthetic, unitary, view of the structure of matter had been blazed by the principle of relativity, which established the identity of matter and energy, and abolished the absoluteness of all concepts.

Having formulated the new synthetic

theory of light, De Broglie applied its general principle to the study of the structure of atom. He thought that the failure of Bohr's hypothesis to stand refined spectrum-analysis might be analogous to the failure of Newton's corpuscular theory of light: electrons might not be pure particles as postulated by Bohr.

Following up the new line of approach, Professor Schroedinger conceived the electrons not as tiny specks of matter, but as electric charge distributed around the nucleus of the atom. The microcosmic electric field was pictured by him as in a state of vibratory motion. On the foundation of that hypothesis, he formulated the theory of wave-mechanics. Any possible doubt in this connecton was further dispelled by the fact (demonstrated by Schroedinger as well as by Professor Born of Goettingen, who also had been working on the problem independently) that the several theories about the structure of atom, formulated independently, all equally led to results as actually observed through spectrum analysis.

The fact is of conclusive philosophical significance. Such an unanimity of theories, all established independently, through more or less pure abstract reasoning, decisively dispels any possible doubt about the objec-

tive reality of the subject of their common concern. Our present knowledge about the ultimate constituents of the Universe may be uncertain; atomic mechanism may still be only a partially solved problem; the electron may not exist in space and move in time like a conventional particle of matter; the interior of atom may properly belong to the category of the unobservable; nevertheless, there cannot be any doubt about it that atomic physics deals with material realities which exist objectively, outside the mind of the physicist. Its theories are not the bridge over which one passes from the imaginary reality of the physical Universe to the real realities of the mental world. They do not prove that the roots of things are to be traced into an incomprehensible region of unobservables, which are unknowables. The new physics does not analyse physical phenomena down to an ultimate constituent which is "mind stuff". In short, it does not flow into the unfathomable ocean of metaphysical speculation.

The sum and substance of the entire body of the theories of atomic physics is that ultimately matter possesses both the corpuscular and undulatory properties. Just as we are no longer surprised to find both the properties in light, so it will be with matter

as a whole, before long. The deeper we penetrate into the structure of matter, into the foundation of the physical Universe, the more precise becomes our knowledge. The successive theories do not cancel each other. The fact that our past knowledge was defective does not prove that the present is unreliable; that we are dealing with unknowables. On the contrary, it proves that objective realities, existing outside, independent of our mind, cannot be fitted into our traditional moulds of thought. The task of science is to know them as they really exist. Those accustomed to think in terms of absolute catagories—a habit rooted in the background of religions and metaphysical culture —are bewildered by the new discovery, and are prone to make a mystery out of it. But conventional modes of thought ultimately break down under the impact of new knowledge. Our mind is moulded by our knowledge of nature. The discovery that nature knows no absolute categories will necessarily free our mind from conventional concepts, and teach it to think in terms of relativity.

The Quantum Theory teaches us to conceive light as a phenomenon corpuscular as well as undulatory. The principle of relativity abolishes the distinct concepts of space and time, and teaches us to visualise things

in a four-dimensional continuum. The wave theory of matter, which is the product of the two, will similarly teach us to approach the ultimate constituents of the Universe with a mind free from the concept of indivisible particles—a concept which dominated physics, so fruitfully, ever since the days of Democritos. Just as changes and readjustments in the theory of life do not abolish life, similarly, the impending revolution in the concept of matter does not abolish matter; does not merge physics into metaphysics.

By reducing the physical world to a dynamic, unitary sub-stratum, modern physical research finally solves the old philosophical problem of substance. It is now meaningless to distinguish the essence from its properties; to differentiate the reality from appearances. It was necessary to postulate an essence of things, when the diverse aspects of physical existence were still to be traced to a common foundation. That having been done, the notion of an invariant essence, distinct from changing properties, becomes superfluous.

Primordially, matter is not something which exists in space and changes in time. It is the sole existence. The existence of matter is realised in its transformation into multitudinous patterns. The concepts of

space and time are derivative categories, representing respectively the geometrical and chronological functions of material existence. In the absence of matter, there will be neither space nor time. It is obviously absurd to make the reality of matter conditional upon its subservience to categories, the reality of which depends on the reality of matter itself.

The physical world exists. It is not to be constructed by the mind of man. It is there, to be studied, explained, known, understood. That is the function of science. Science has performed that function, and has not discovered the roots of physical reality vanishing into nothingness. It has not reduced matter to mind. It has proved the self-sufficiency of matter. Matter is an objective category. Self-sufficient objectivity is the ultimate reality. Therefore matter is the only reality. It is ontologically real. Its epistemological reality logically follows.

Like substance, causality also remains in new physics. The application of the statistical method in the researches of atomic physics does not disprove causality. The degrees of the uncertainty of our knowledge are expressed in terms of probability. Criticism does not permit the surreptitious transfer of the uncertainty of our knowledge to

the object of knowledge. The probability of a thing or event is proportional to our knowledge concerning it. The greater the knowledge, the greater the probability. When predictions, made as probabilities, all happen to turn out to be correct, it is no longer a matter of probability. In the utter absence of the element of uncertainty, associated with the conception of probability, the conception must disappear. But in the formal logical sense, it still persists even then on the strength of the argument that, the calculations being based not on exact knowledge, but on probability, one can never say for certain that the next prediction will not be wrong. From the point of view of this extravagance of pure empiricism, no scientific theory has unquestioned validity. We should always expect the next pot of water to freeze when placed on fire. The implication of the argument is that no theory is possible except on the basis of an absolute knowledge of all the possible phenomena to be embraced by it; that we cannot know anything unless we know everything. As with the human faculty of cognition it is not possible to know everything all at once, this theory of knowledge leads straight to the doctrine of revelation: Truth can never be known, it is revealed.

The laws of being are laws of strict causality, whereas the laws of becoming are laws of probability. Becoming presupposes being; therefore, statistical laws are based upon the assumption that the entities involved in a process are individually governed by strict causal laws. It would be impossible to work out any law of probability, except on this assumption. A collective order cannot be founded upon chaotic individuals. If some individuals are found to defy the statistical law, that does not prove the failure of the strict laws of causality; the logical inference to be made therefrom is that our observation has been faulty—the law has not been put to a correct test. On the other hand, the conception of a being, independent of becoming is a purely abstract conception. Isolated or static being is a logical category. It has no physical reality. Therefore, in extreme cases, such as in the case of an isolated electron, strict law of causality may not be experimentally demonstrated. Nevertheless, it is logically incontestable.

By the very nature of its subject matter, wave-mechanics is bound to be statistical. It does not deal with isolated particles. It has reduced the ultimate constituents of nature to a state of collective becoming. Conse-

quently, the law governing matter, deep down in the foundation of its structure, must be statistical. But when the law, discovered inferentially, is always borne out by facts observed in nature, and by experimental data, its accuracy cannot be doubted. Any uncertainty, then, becomes only a matter of formalist logic. The difficulty arises only when a necessarily statistical law is tested by mathematical experiments with individual electrons as ideally isolated particles.

Determinism and probability are not mutually exclusive conceptions. On the contrary, a synthesis of the two enables us to have a truer picture of relations as they really exist in nature. Co-ordinated with the concept of probability, determinism loses its teleological connotation. On the other hand, statistical laws cannot have any validity if the principle of causality is totally denied. In short, probability is the dynamic view of determinism. Moreover, induction remains the rock-bottom of scientific research; but a rigidly mechanical view of determinism cannot be logically reconciled with induction. Probability is methodologically preferrable. With this principle, scientific theories gain in purely logical validity, while casual connection remains empirically indisputable. When the num-

ber of entities entering in calculations is so very great as to be incalculable, almost approximating infinity, then there can be no absolute certainty about prediction. All the causal influences, even upon a particular event, cannot possibly be traced. In such a situation, determinism has to be interpreted in terms of probability. But determinism remains. The innumerable number of possibilities of a given situation are all determined. Even if the most improbable event happened, it would be causally determined.

There is no place for miracles in nature. The new physics does not let them into its world. One of the leading Quantum physicists, Professor Born of Geottingen, goes to the extent of suggesting that the foundation of the physical world may be regarded as a "field of probability". But he is decidedly of the opinion that the doctrine of probability in no way affects the basic principle of physical science that, whatever happens, is caused; something does not come out of nothing. He says that "it would be entirely wrong to proceed to introduce a belief in miracles into our view of nature."

Rejection of the idea of causality—that there are invariant relations in nature—will mean blasting the very foundation of science. For, the point of departure of all scientific

enquiry is the belief that the universe is a law-governed system, and that these laws can be discovered, understood and quantitatively stated. As long as predictions can be made, and events happen approximately as predicted, the principle of physical determinism stands.

CHAPTER VII

THE PROBLEM OF BEGINNING AND END

Instead of resurrecting religion in any form, modern physical research enables us to dispense with the **deus ex machina** of Newton. On the other hand, it does not seem to make any room for the ultra-modern mathematical god, invented by the mathematical genius of Sir James Jeans.

One of the fundamental laws of classical physics—the Second Law of Thermo-Dynamics—seemed to prove the doctrine of creation. According to it, the world was doomed to die eventually. The fate of the world is "heat death". In course of time, the entire store of solar and stellar radiation will be poured out and absorbed in the vast cold expanses of inter-stellar space. Uniformly distributed over such a vast area, the total amount of heat will be imperceptible, and consequently the entire Universe will be frozen. A world so definitely doomed to distruction must necessarily have been created at a definite time in the past.

According to the law of entropy, any

physical system must reach the state of thermo-dynamic equilibrium, that is, a perfectly even distribution of energy, within a definite period of time. If this physical Universe of ours had really existed from an infinite past, it would have frozen to death long ago. Any definite period of time, however long, is but a small fraction of infinity. As the inevitable fate has not yet overtaken our physical Universe, it could not have existed from the infinite past. Therefore, it must have been created at a definite time.

Such a notion of creation cannot be conceived except with that of a supernatural creator. Therefore, Eddington writes: "It has been quoted as scientific proof of the intervention of the creator at a time not infinitely remote." But he characterises "as somewhat crude this naive theological doctrine which is at present to be found in every text-book of thermodynamics, namely, that, some billions of years ago, God wound up the material Universe, and has left it to chance ever since." ("The Nature of the physical world").

The development of the physical science during the last half of a century dispels the dread of a "heat death". While the Second Law of Thermo-Dynamics remains valid, as a physical law, highest entropy no longer

looms ahead as the Nemesis. As a matter of fact, even previously it did not necessarily bear out the doctrine of creation. The very utmost that could be proved "scientifically", without falling into "naive theology", is that the Universe, as we know it, as a process of physical organisation, did not exist from eternity—that it had a beginning; and therefore, logically, it cannot last for an infinite time; it must come to an end. This admission does not compel us to believe in a **deus ex machina,** who interferes in the physical process periodically, winding up the run-down Universe, from time to time. We are only required to visualise mechanical cosmic evolution in successive cycles. It is conceivable that, after the end of each cycle of cosmic evolution, the evenly distributed heat somehow accumulates here and there, and a new cycle begins. This, of course, would imply a reversal of the passage of heat. But such reversal is not altogether excluded by the Second Law of Thermo-Dynamics.

The highest probability against a reverse process holds good only when heat is unevenly distributed. The law has been deduced from the observation of the passage tion. In the ideal state of thermo-dynamic equilibrium, it would have no application.

Then, the notion of reversal would have no meaning. A state of perfect equilibrium is a purely abstract concept. In physical reality, if ever reached, it could last only for an instant. Then it must tip over, one way or the other. The equilibrium lost, in the very slightest degree, at any point, the Second Law of Thermo-Dynamics would reassert itself instantly, and the cosmic evolution begin all over again, mechanically. Such a cyclic process would be infinite both ways, having neither beginning nor end; and a **deus ex machina** would be utterly superfluous. Nor could the pantheistic conception of God be fitted into such a purely mechanical process.

Ever since the days of Laplace, a whole series of mathematical theories have demonstrated how the evolution of our physical system could have begun from a primordial state of evenly distributed matter. Modern astral physics has developed the nebular hypothesis into a mathematically precise theory. It tells us how the stars and galaxies are formed out of gaseous nebulae, and has found that the process is going on even to-day, in the farthest parts of the Universe.

The absolute prediction of thermo-dynamic equilibrium, amounting to a heat death of the Universe, must be based upon

two assumptions. First, that the total amount of energy involved in the process is limited; and second, that the available store of energy is not infinitely divisible. The assumptions set a limit to our perspective, both ways—macrocosmically as well as microcosmically. To narrow down the field of investigation is necessary for the mathematical calculations of modern physics. But a philosophical approach to the problem of cosmic evolution should not be so arbitrarily handicapped.

No absolute prediction about the thermo-dynamic equilibrium could be made on the strength of the nineteenth century physical theories. Those theories did not discard the concept of infinity; and the classical conception of energy did not preclude infinite divisibility. The fatalistic view of entropy, and the "scientific" theology based thereupon, were not a necessary outcome of the kinetic theory of heat. It was rather a reflection of the spiritualist preoccupation on the part of the physicists. The "scientific" foundation appears to be provided by the new physics. The first assumption, that the total amount of energy is limited, may be backed up by Einstein's Theory of the Finite but Unbounded space (Universe). And the second assumption,

that the available store of energy is not infinitely divisible, seems to find a support in the Quantum Theory.

But entropy affects not energy itself; it governs the organisation of energy. This differentiation is of fundamental importance. Granted that the store of cosmic energy is limited; at the same time, it must be noted that the law of conservation of energy is an absolute guarantee against decrease. The problem, then, becomes a problem of organisation of energy. And the human factor can have something to do in the solution of that problem.

In inanimate nature, the dissipation of heat is an entirely mechanical process, tending towards thermo-dynamic equilibrium; but human intelligence introduces in it a selective element. In technological use, the consumption of energy is highly controlled, regulated and systematised, so as to put a decisive check upon the purely mechanical operation of the Second Law of Thermo-Dynamics. The disorganisation caused in a given unit of energy can be easily passed on to another unit, thus preventing the diffusion of the former beyond a certain limit. When a quantity of coal is burned in the open, the latent energy, having been transformed into heat, gets irretrievably

diffused in the surrounding atmosphere. But when the coal is burned in a furnace, the heat produced goes on to move an engine. Here, the change in the organisation of energy is controlled. Of course, even in this controlled technological process, a certain part of the released energy is lost in the surrounding atmosphere. One of the problems of modern engineering has been to diminish the amount thus lost, and the problem has been partially solved. The leakage may never be altogether stopped, but there is sufficient reason to expect that it will be progressively diminished, and to that extent the spectre of the ultimate thermo-dynamic equilibrium will recede.

The law of entropy enables us to understand the process of becoming, and follow it up as a physical process. It gives a physical content to the concept of time. Without the law of entropy, physics does not present us with a dynamic picture of the world. It simply shows us a physical system spread out in space; but the "flow of time" is absent in the picture. This "strictly scientific" picture of the world, of course, does not correspond to the world of our experience, which does not stand still, but moves on.

The concept of time is inseparable from the dynamic view of the world. It necessa-

rily becomes an intuitive category of thought, unless the dynamic appearance of the outside world can be identified with an actual physical process. Or, an independent objective reality is ascribed to time, and the world is pictured as moving on that ghostly background. This concept of absolute time, together with a similarly metaphysical concept of space, vitiated philosophical thought for a considerable time. The law of entropy, long before the Theory of Relativity, indicated the way out of the vicious circle, as far as time was concerned. By enabling us to detect the dynamic character of the physical Universe, and to trace the process through successive stages, it revealed the real nature of time, as a convention for comparing intervals between events. Time, thus, ceased to be an empty concept—of an imaginary, metaphysical category, existing by itself, defying all defintion. It came to be conceived as a conventional mode of measuring the dynamic movements of the physical world.

This revolution in the concept of time, though implied in the law of entropy, was not fully felt until physics came under the domination of the Principle of Relativity. The concept of time acquires a content of reality only when it is associated with a

causal chain of events. In other words, the phenomena of causality, events following events continuously in an unbreakable chain of cause and effect, bring the category of time within the reach of our compherension.

Then in the limited scientific sense, that is, apart from its philosophical implications, the concept of entropy may have to be modified in the light of the electric theory of matter. A law of thermo-dynamics may not be strictly valid in electro-dynamics—not Maxwellian, but as elaborated by contemporary atomic physics. Notwithstanding the fact that new physics abolishes the distinction between thermal energy and electricity, there is an experimental fact which indicates the way to a modification of the concept of entropy. It is that the electric current passes from the negative to the positive pole. In other words, the direction of electricity is from the minus to the plus. The passage of thermal energy is just in the opposite direction—from the plus to the minus. This fact seems to offer the ground for the inference that the irreversibility of the passage of thermal energy may be counteracted, or even actually reversed, when energy operates in the form of electricity. And now we know for certain that thermal as well as radiant energy is of

electrical nature. More than that: the identity of matter and electricity has been conclusively established, in consequence of the equivalence of matter and energy. When, down in the structure of basic substance, all motion, in the form of electric currents, is found to be from the minus to the plus, it becomes difficult to maintain that the Second Law of Thermo-Dynamics is unrestricted in its operation. As a law of thermo-dynamics it remains as valid as ever; but the electro-dynamics of the microcosmic world is unaffected by it.

It seems that deep down in the foundation of the structure of the physical Universe, there is a check upon the process of the diffusion of cosmic energy towards the dreaded thermo-dynamic equilibrium. The dispersive process of thermal energy seems to be counteracted by electricity flowing in the contrary direction. Thus, even if the store of cosmic energy was limited, the process of shuffling would never reach the end; energy could never be evenly distributed. The process of diffusion on the surface is upset by a counter-process deep down in the structure of matter.

The twentieth century physics has been finding still other facts which enable us to doubt the fatality of the doctrine of entropy.

These facts concern the store of cosmic energy. Unforeseen sources of energy are being tapped.

The daring dreams, occasioned by the discovery of radium, have not been realised as yet. The newly discovered radio-active elements have not proved to be the philosopher's stone as regards energy. All technological processes have not been revolutionised by small bits of metallic radium furnishing incalculable quantities of motive power.* The expected practical consequences of the discovery may appear to-day to be a remote possibility, or even doubtful. Nevertheless, as regards the theory of energy, its significance is far-reaching. The new insight into the structure of matter, gained from the study of the phenomena of radio-activity, promises to reveal the fact that energy, as known to the nineteenth century physics, is but a small fraction of the total amount of cosmic energy, and this amount may be found to be infinite, not in the speculative metaphysical sense, but in a concrete sense, indicated by the Principle of Relativity.

The real significance of the discovery of

* This was written years before the atom bomb was manufactured. Now the statement can be reasonably modified.

the phenomena of radio-activity is very much greater. It is not to be measured by the store of energy to be found only in the radio-active substances. The study of the disintegration of the radio-active substances has led to the discovery that matter is actually transformed into energy. Radio-activity is nothing less than this "miracle" taking place in nature. The vastness of the supply of energy from the newly discovered sources can be visualised with the help of Einstein's equation setting forth the equivalence of matter and energy. The amount of energy produced from the disintegration of any mass is equal to the mass multiplied by the square of the velocity of light. It means that a very minute particle of matter, when decomposed, produces a quantity of energy many many thousand million times greater.

It has been computed theoretically that a gramme of the mass of any substance would yield as much energy as is to-day obtained from three thousand tons of coal. This enables us to imagine what an inexhaustible source of energy will be tapped through artificial transmutation of mass into energy, the possibility of which has been theoretically established.

This possibility of a progressive increase

of the store of energy must decisively counteract the tendency towards thermodynamic equilibrium. The advance of knowledge as regards the structure of matter has led us to an unforeseen source of energy of such a nature as appears to be beyond the purview of the Second Law of Thermo-Dynamics. All calculations of cosmic energy, made on the basis of the classical atomic theory of matter, must necessarily be recast. Now the source of cosmic energy may be reckoned as inexhaustible, even if physics would avoid the metaphysical term infinite.

Nevertheless, the Quantum Theory has introduced atomicity into energy, thereby providing ground for the assumption that energy is not infinitely divisible; and Einstein's Theory of the Finite but Unbounded Universe seems to place the traditional concept of infinity outside the pale of physics. Let us see if these theories of new physics really help the fatalistic doctrine of entopy to survive the weakness of its origin.

We shall take the Quantum Theory first, to see if it really establishes that energy is not infinitely divisible. That is the decisive point. Atomicity of energy alone would not prove anything. The term "atom" no longer signifies an indivisible

particle. What must be proved is that energy is composed of indivisible units, and that the number of these units is finite. Eddington revived this bogey of heat death; yet he admits that "when the number involved is infinite, there can be no end to the process of shuffling, and the equilibrium will never be reached."

The Quantum is not an atom of energy. It is not a compact entity as the atom of matter was believed to be. It is a composite thing,—the product of a quantity of energy and a period of time. Both the component parts are variable. The theory of constancy and indivisibility is based upon the observed fact that, while the component elements are variable, this product is always the same. Constancy of the Quantum is definitely proved by this fact, but not necessarily the indivisibility of its energy-content. The Quantum is constant **externally**, that is, in its relation with other objects. Internally, it is not even constant. Its structure is variable. An object with a variable structure cannot be indivisible. Energy, thus, is not reduced to the common denominator of an elementary indivisible unit.

The above analysis of the new theory about the structure of energy justifies the inference that the number of the units of

energy, as found in nature, must be infinite. The variability of the amount contained in each unit would alone warrant this inference. Thus, in the light of the Quantum Theory, the structure of energy appears to be of such a nature as precludes the possibility of thermo-dynamic equilibrium.

But there still remains Einstein's Theory of the Finite but Unbounded Universe. The store of energy, however great, in a finite Universe must be finite. But the finiteness of the Universe is qualified in the theory by the idea of unboundedness. Apparently, it is a self-contradictory conception, a paradox. It is a logical outcome of the Theory of Relativity; but it is rather a non-Euclidean geometrical abstraction than a pictorial representation of the physical system. Although, mathematically, the theory is practically unchallengeable, its experimental verification is impossible within the limits of the Theory of Relativity. The new physics has thus brought us on the boundaries of a still newer physics.

This bold conception has enabled Einstein to round up all the diverse theories dealing with matter, energy, radiation, electricity and all the allied categories of the physical world, into a logically perfect

system. Thanks to this great achievement, progressive accuracy of the calculations of physics has been guaranteed against speculative deviation, which would be inevitable so long as the abstract concept of infinity was not put out of the realm of scientific investigation. To measure is the main function of physical science. It can, therefore, have no use for the immeasurable. Philosophy, however, cannot dispense with the concept of infinity without placing an arbitrary limit to the spiritual perspective of man. Even physics would be confronted with the baffling question—what is beyond?—should it press the hypothesis of finiteness too dogmatically. Therefore, it is incorrect to assert that Einstein has abolished infinity. What he has done, is to make the very sensible declaration that the immeasurable cannot be measured, and has marked out a measurable domain, so that physical investigation could be carried on with an ever increasing accuracy. Once the gigantic task, thus set to physics, is accomplished, then the time will come to see farther ahead; and the accomplishment of this initial task will provide man with the equipment necessary for the purpose.

Infinity, in the abstract sense, is beyond human conception; as such, it is but a matter

of empty speculation. Infinity can be conceived only as the endlessness of the object of our knowledge, and the unlimited possibilities of the cognitive faculty of the human being. But knowledge, as it is attained, presupposes a concrete, therefore finite, object to be known. From that point of view, the conception of Finite but Unbounded Universe is fully legitimate in the scientific sense; that is to say, in the sense of the technique of acquiring accurate knowledge of the physical system. It is philosophically permissible also; firstly, because philosophy is nothing but a synthesis of scientific knowledge; and secondly, because the conception does not **abolish** infinity, but substitutes an idle, speculative, abstract, static, concept by the dynamic perspective of a realisable process. Infinity is abolished as a time-worn fiction, so that it can appear as a conceivable reality.

It is quite evident that Finite but Unbounded Universe is a working hypothesis, necessary for the exigency of measuring with greatest accuracy the fraction of the cosmic expanse, for the present accessible to our observational survey. The fraction of the cosmic space surveyed from the earth is necessarily spherical, because the instruments of observation and measurement used

for the purpose cover the same distance on all sides. There is no reason to believe that the spherical space of our observational survey is not a small sphere within a very great sphere. On the contrary, it has been ascertained that the star gallaxy, to which our sun belongs, is not situated in the centre of the surveyed celestial domain. Therefore, we can just as well expect to find the real Universe to be something like this: When we have measured, surveyed and charted the space marked out by the spherical model, a new vista will open up before us, and the spherical model will be theoretically applicable equally to the new field of survey. That will continue **ad infinitum.** Thus, Einstein's abolition of infinity turns out to be the discovery of a method to measure the infinite. Of course, the object of measurement being infinite, the end will never be reached. But the measurement will be continued **ad infinitum,** although, at every given stage, it will be exact, being concerned with concrete measurable quantities. Infinity as an objective reality remains; only it ceases to be a metaphysical concept of purely speculative value.

An unbounded Universe is infinite; consequently, the universal store of energy is inexhaustible. If it is reduced to element-

ary units, their number will be infinite, and the process of their shuffling will be endless; the thermo-dynamic equilibrium will never take place.

Moreover, the theories of thermo-dynamics have no validity in the microcosmic world, where reversibility or irreversibility has no meaning. The vibratory motion of electrons is not governed by the laws of thermo-dynamics. The irreversibility of energy processes is absolute only in the sense that they indicate the causal chain underlying cosmic evolution. It is, however, open to serious doubt, a doubt strenghtened by the discoveries of contemporary physics, in the microcosmic as well as the macrocosmic domain, in so far as it conveys the notion of an end of the present physical system. The real issue involved in the doctrine of entropy is not the technical scientific question of reversibility or irreversibility; it is the profound philosophical problem concerning the beginning and end of things.

To-day, no serious person would be convinced by the naive theoretical solution of the problem, which used to be formerly deduced from the Second Law of Thermo-Dynamics. When it is definitely known that the process of cosmic evolution, which has brought about the present physical system,

has been going on for a practically incalculable time, the pure speculative nature of the idea of a beginning becomes palpable. Biological time, that is, the history of organisms, takes us no less than a thousand million years back. The precedent period of geological evolution covers a still longer period. Then, there was the period of the formation of our solar system, which was still longer. Finally, the process of the evolution of the celestial bodies, stars and gallaxies, out of the background of primordial matter. That process, calculated in astronomical time, lasted for a period of many many trillions of years. And now we know that the process did not stop there. Therefore, it is sheer prejudice that may still concern itself with the beginning of the world.

Science disregards that speculative notion. Scientific philosophy, that is, the doctrine about the nature of the world, based upon exact knowledge, is no more concerned with it. In the light of the vast store of exact knowledge—a store that grows every day—the antiquated notion of beginning and end loses all meaning. With that hoary notion, must also go the doctrine of creation and the associated teleological view about the ultimate fate of the world.

While the notion of a beginning is overwhelmed by the incalculableness of the past, the hypothetical end does not seem to be within a measurable distance. The perspective of the future of the physical system is practically unlimited. The predicted heat death would overtake the Universe only when all the stars would have poured out their radiation into the space. If we probe a little deeper, we find that the Universe has a still longer rope. In addition to the grown-up stars, the world has a very large store of raw materials to manufacture new stars. The hundred million spiral nebulae in the observable Universe are found to be in various phases of evolution towards gallaxies of new stars. Some are still extremely tenuous gaseous mass. Then, there is still another link in the chain of cosmic evolution. Today, we know that there is no such thing as empty space. The inter-stellar and inter-gallactic expanses are filled with extremely diffuse matter. So, radiation is not poured into a bottomless void. It is being absorbed by the diffuse matter in what is called "empty space". We further know that matter and energy are mutually convertible. Consequently, it is quite permissible to assume that heat, poured out into the cold regions of the so-called empty space, contri-

butes to the crystallisation of the diffuse stuff into electrons and protons. The result of such a hypothetical process would be thickening of the diffuse matter, and eventual formation of new physical systems—nebulae and stars.

The picture presented by the physical science of our day does not contain any indication that the world ever had a beginning, or will ever have an end. The process of physical evolution is not reversible; but it is recurring. The radiation from the sun does not return to the sun; but following a circuitous route, yet to be discovered by science, it seems to crystallise into a new source of radiation. Particular physical bodies in the cosmic organisation may possibly freeze to death. The heat poured out by them, however, is not irreparably lost. It re-enters into circulation through the formation of gross matter, and eventually new stars. In the long run, life may be breathed again even into the frozen bodies. And all this takes place mechanically, without the intervention, at any point of the infinite process, of an extraneous agency. The discoveries of modern science, with all its obvious and admitted deficiencies, have completed this picture of a self-contained, self-operative, physical Universe.

CHAPTER VIII

THE MYSTERY OF LIFE

Until the middle of the ninteenth century, biology was largely dominated by vitalism and teleology. The mystery about the origin of life was believed to be beyond the reach of science. It was generally held that behind the veil of that mystery was the transcendental realm of a creative force which knows no law except its own, and which, in its turn, is never to be comprehended by human understanding. It was pointed out that the very term "organic" or "living" was the antithesis of the concept of inert matter; it stood for a spiritual being. It was further maintained that the purpose of a creative power pervaded the animal kingdom. Every particular organism was supposed to be created to fit into its allotted place in a grand scheme of divine providence. The more advanced was the knowledge about the wonderful phenomena of organic nature, particularly of man, the stronger became the anthropomorphical atavism. It was argued that such a wonderful machine could be created and run only by an equally wonderful machine, but immensely more perfect.

Upon the discovery of the cell, the modern science of the phenomena of motion (life) in animals and plants, namely, physiology, also adopted the mechanistic view. But the morphological sector of biology—the science dealing with the origin and growth of the forms of organic beings—persistently held on to teleology. So long as the mechanistic law determining the origin and development of organic forms was not discovered, the mysterious hand of the creator was assumed behind the complicated phenomena which were believed to be so many carefully manufactured parts of the great universal machine through which the divine purpose was realised. A miracle remained the cause of the organic world. It did not make any difference whether the miracle was performed by a personal God or the mysterious vital force. Finally, Darwinism drove teleology out of its last stronghold-morphological biology.

The basic principles of Darwinism, outlined previously by other eminent naturalists, such as Lamarck, St. Hilaire, Goethe and others, completely revolutionised the science of biology. Formerly, biology simply discovered, verified and assorted various organic forms. Darwinism made us acquainted with the causality of the process

of continuous development which runs throughout the organic world. Therefore, Haeckel defined Darwinism as "the mechanical explanation of organic forms, or the science of the true cause of nature". Darwinism, once for all and definitely, defined the position of man in nature. It established the groundwork of a non-miraculous history of the development of the human race.

Darwinism explained the mechanism of the evolution of organic forms from the lowest to the highest. The works of Huxley and Haeckel suggested the possibility of the spontaneous generation of organic matter out of inanimate nature. Still there remained "the missing link" to baffle biologists and to provide the spiritualists with what they declared to be an irrefutable argument against materialist philosophy. Eventually, the baffling problem of the "missing link" was also solved theoretically by the discovery that there is no uniformity in nature; that the process of evolution includes sudden jumps. In the beginning, the discovery appeared to challenge the validity of the law of causation. Later on, it turned out to be the explanation of what had previously seemed to be erratic in the process of evolution. The theory of mutation revolutionised the doctrine of evolution. In the organic as

well as in the inorganic nature, quantitiative changes suddenly become qualitative. That happens whenever diverse elements involved in a particular process reach a point of interrelation in their respective movements. The collective momentum attained at such a point assumes the form of a sudden jump which disturbs the gradualness of the process. A new phenomenon springs into being with no visible immediate causal connection with its background. The causal connection, however, is here—hidden in the swift process of the change becoming qualitative from quantitative. For instance, steam is separated from water by a sudden jump in the molecular motion of water caused by the application of heat. Sudden changes are not erratic events. They are involved in the process of evolution brought about necessarily by the cumulative effect of the operation of the law of causality. A particular process of evolution culminates in a revolution which marks the origin of a new species.

The conclusive establishment of the fact that the complicated human organism is but the highest form in the evolution of organic matter which, in its turn, is the result of a specific physico-chemical process involved in inanimate nature, drives teleology and spiri-

tualist philosophy out of the last ditch. Life is not a mysterious immaterial force. It grows out of inanimate matter in a certain state of organisation. Intelligence is a physiological function; brain is the organ of thought; and thought is the function of the brain. In short, the vital phenomena are not manifestations of a mystic metaphysical force. They do not testify to a spiritual essence of man. They can be traced back to the lowest form of organic matter.

Half a century before Darwin, Lamarck had laid down in broad outlines the mechanistic principle of modern biology. He wrote: "Life is nothing more than a mere physical phenomenon. All appearances of life can be traced back to mechanical—physico-chemical—causes which lay in the very structure of organic matter. The simplest forms of animal and plant, which represent the lowest stage of the process of the evolution of life, have grown and are still growing out of the root cause. The old philosophers thought of life-force—of a soul —of the animal. They ascribed souls even to plants. Instead of positive knowledge, they operated only with words, and set up an unfounded and unclear notion. But as soon as we leave nature, and deliver ourselves to the fantastic fabrications of the power of

imagination, we lose ourselves in confusion and blunder. The only knowledge that we can have is, and always will be, that which is derived from our positive study of the laws of nature." ("Zoological Philosophy").

Darwin, however, carefully avoided the question of the origin of organisms or organic matter. In "Origin of Species" he expressly remarks that he has nothing "to do with the origin of the soul nor with that of life".

Haeckel carried Darwin's theory to its logical conclusion, and reinforced the Lamarckian hypothesis of spontaneous generation of organisms with observational data. He wrote: "If we do not accept the hypothesis of spontaneous generation, then, at this point of the history of development, we must have recourse to the miracle of a super-natural creation. The creator must have created the first organisms or a few first organisms from which all others are derived, and given them the capacity of developing further in a mechanical way. To me, the idea that the creator should have in this one point arbitrarily interfered with the regular process of development of matter, which in all other cases proceeds entirely without his interposition, seems to be just as unsatisfactory to a believing mind as to a

scientific intellect." ("The Riddle of the Universe").

Scientific knowledge about the history of the Universe shows that organic beings did not exist on this earth from time immemorial. They could not, because of the uninhabitable state of this planet as well as of the other members of the solar system. Only at a certain stage, after the earth's surface was covered by water, organisms came into being. The descent of man can be traced all the way back to that remote point of history of the earth. The preponderance of water in organic matter is evidently due to the fact that water is the pre-condition for the birth of organisms.

Haeckel discovered the very simplest forms of organism floating on the surface of the sea. He called them the **monera** and described them as "organisms without organs". He wrote: "They are very small living corpuscles, which strictly speaking do not deserve the name of organism, not composed of any organs at all, but consist entirely of shapeless, simple, homogeneous matter. The entire body of one of these **monera** is nothing more than a shapeless, mobile, little lump of mucus or slime, consisting of an albuminous combination of carbon. A simpler or more

imperfect organism we cannot possibly conceive." (General Mophrology").

Huxley also discovered a similar form of lowest organism in the depth of the ocean—twelve to thirteen thousand feet below the surface. They are found in great quantities, sometimes in the shape of roundish, formless lumps of mucus, and sometimes in the form of a network of mucus, covering fragments of stone and other objects. Huxley named these creatures of his discovery **Bathybius Haekelii.**

The discovery of these simplest and lowest organisms threw some light on the secret of life. At the time of Lamarck, and even later on, the probability of the hypothesis of spontaneous generation was generally doubted, because the lowest forms of organisms known then were of relatively complex nature. The very term "organism" means a combination of various parts (organs), which function in unison to produce the phenomenon of life. The **monera** and the **Bathybius Haekelii** were not composite organisms; they "consist solely of a single chemical combination and yet grow, nourish and propagate themselves." (Haeckel) A simple compound of carbon is the seat of original life, which is nothing more mysterious than the totality of the molecular

motion of matter. Originally, all organisms are nothing more than simple lumps of an albuminous substance called protoplasm—a combination of carbon with oxygen, hydrogen and nitrogen.

There is no essential difference between organic and inorganic matter. All material bodies are formed out of the combination of such chemical elements as carbon, oxygen, hydrogen, nitrogen, sulphur, potassium, sodium, etc. These chemicals are also found in vegetables and animal bodies. There are no such elements which are absent in the inorganic substance. The difference lies in the "vital force", in other words, life. That is to say, when a certain combination of a number of chemical elements produces the phenomenon called life, it enters into the domain of organic nature. The primary manifestation of this phenomenon is the process of nutrition and multiplication. The simplest and lowest forms of organism discovered by Haeckel and Huxley appear to mark the boundary line between the organic and the inorganic nature. Haeckel wrote: "On account of the perfect homogeneity of the albuminous substance of their bodies, on account of their utter want of heterogeneous particles, the **monera** are more closely connected with the inorgana than with organ-

isms, and evidently form the transition between the organic and the inorganic world of bodies."

Protista is the collective name given to the different forms in which original organic matter exists, the monera being the lowest of the forms. They do not as yet contain the kernel, that is, they have not yet developed the process of differentiation inside the mass of albuminous carbon compound. The next higher in order is the amoeba, which contains the kernel, which is formed simply by contraction and condensation of the substance in one point.

"All protista have soul, that is to say, they are animate, as well as all plants and animals. The soul's activity in the protista manifests itself in their irritability, that is, in the movements and other changes which take place in consequence of mechanical, electric and chemical irritation of their contractible protoplasm. In the protista, as in all other organisms, the activities of the soul are traceable to molecular motions in the protoplasm." (Haeckel).

The infinitely variegated and numerous physical and chemical properties of the albuminous substance (carbon compound) are the cause of the so-called vital force, which distinguishes organic bodies from the

inorgana. Until the beginning of the nineteenth century, science was ignorant of this fact. The discovery of the cell revolutionised physiology. It showed that all forms and motions of organic bodies represented the aggregate of the forms and motions of the cells, which composed all organic bodies. Later on, it was discovered that cells were small bits of plasma with a nucleus which appeared to be the centre of the vital phenomenon. The discovery of **monera** had revealed the most interesting fact that a lump of slime without the centre of the vital phenomenon was also an "organism", because it nourished and propagated itself. The inevitable scientific inference therefrom is that the growth of the cell—the seat of the vital phenomenon—is inherent in the physical and chemical properties of the plasma, that is, carbon compound.

"The peculiar chemico-physical properties and specially the semi-fluid state of aggregation, and the easy decomposibility of the exceedingly composite albuminous combinations of carbon, are the mechanical causes of those peculiar phenomena of motion which distinguish organisms from the **inorgana**, and which, in a narrow sense, are usually called life." (Haeckel, "The

History of Creation").

The absence of any fundamental distinction (as regards composition, formation and motion) between organic and inorganic bodies destroys the mystic faith in the supernatural creation of the vital force. Spontaneous generation of life out of matter becomes easy of conception. **Monera** and **bathybius Haeckelii** show rudimentary functions of life in "organisms without organs". There we have nearly reached the point where life spontaneously grows out of a certain combination of inorganic matter. All that remains to be found is how this particular compound of carbon is first formed. Even failure to establish this last link will not necessarily leave the chain incomplete. For, it is quite possible that spontaneous generation no longer actually takes place, owing to the change of climatic and atmospheric conditions of the surface of the earth. In remote primeval times, there was a very great abundance of carbon (the coal deposits bear eloquent testimony to the fact). It can be very reasonably assumed that under those favourable conditions organic matter came spontaneously into existence, and ever since has been multiplying and propagating itself as the foundation of all the forms of vegetable and animal life.

But it is not necessary to depend altogether on this logically irrefutable supposition. Although experiments to establish the hypothesis of spontaneous generation have until now failed to produce satisfactory results, all the avenues are by no means exhausted. On the contrary, the magnificent achievements of bio-chemistry and physiology have all but destroyed the miracle about the creation of organic bodies. A century ago, it was asserted that chemistry would never be able to manufacture the so-called organic compounds which were supposed to be the creation of the mysterious supernatural vital force. Yet, already in 1828, the miracle was done by a mortal man —Professor Woehler of the University of Goettingen. More recently, synthetic chemistry has succeeded in producing a large number of organic carbon compounds. Some of them are so complicated as to come very near to the albuminous substance called plasma.

Organic substances, such as sugar and protein materials, are formed when ultra-violet rays act on a mixture of carbon-dioxyde, ammonia and water. This has been experimentally demonstrated. This process must have been the origin of life on earth. Fermentation is the origin of vital

processes. In the remote period when life originated, there was no oxygen in the atmosphere. Even now it can be observed that life lives by fermentation before it can have oxygen. Life is enzyme action, which is a purely chemical process. Willstaetter is of the opinion that life is the sum total of biochemical changes, and vital energy is only a form of physical energy.

A systematic experimental investigation into the origin of life began when the discoveries of Redi and Leeuwenhoek in the middle of the seventeenth century led to the formulation of the doctrine of biogenesis. Pasteur's researches, more than a hundred years later, also led to the conclusion that living beings originated only from other forms of life. But the origin of life was still to be discovered; and most biologists continued to believe, as Lamarck, Cuvier and others had done previously, that life had originated from dead matter in the remote past. Pasteur held that fermentation was impossible without life. Before him, Schwam had shown that yeast was a mass of micro-organisms. Pasteur maintained that, when those organisms were killed (sterilised), no fermentation could take place. Liebig held a different view. Pasteur's researches, however, seemed to prove that a

living organism was necessary to produce fermentation. But Buchner produced fermentation with crushed (dead) yeast. The experiment proved that fermentation was a catalytic process produced by a substance itself dead, but which could be obtained, for the time being, only from the yeast.

Primeval atmosphere (after the cooling down of the earth's crust) contained no oxygen or very little of it. The present supply of Oxygen warrants that theoretical deduction. At present, there is just enough of it to burn all the store of coal and other organic remains. There is evidence of the existence of carbon-dioxide and ammonia in the primeval atmosphere. Ultra-violet rays cannot reach the earth's surface, because they are stopped by ozone in the upper atmosphere and oxygen itself in the lower strata. When there was no oxygen, they reached the earth's surface and acted on a mixture of water, carbon-dioxide and ammonia. The water covering the earth's surface at that time was warm, conducive to intense chemical activity. In the welter of chemical changes, complex carbon-compounds were produced, some of them of colloid nature, functioning as catalysts or enzymes. That state of physico-chemical

organisation of inorganic matter could very well be the breeding ground of life. At its origin, life did not grow out of another organism, but out of chemical energy resulting from inorganic compounds. This inferential conclusion is corroborated empirically by the fact that there are kinds of bacteria which do not require oxygen; they derive energy from chemical changes (fermentation). Most probably, they belong to the order of bacteriophages.

Primitive forms of life did not grow out of the original organic substance until the water on the earth's surface cooled down considerably below the boiling point. No oxygen was available. The precursor of life derived energy from fermentation—a chemical process. Enzymes are fermentations. Nobody maintains that they are living beings. The bacteriophage is a step beyond the enzyme on the road to life. At that stage also appear the viruses. The bacteriophage multiplies; therefore, it is a living or semi-living organisation.

We know life only as connected with certain definite chemical compounds which consist essentially of carbon, hydrogen, oxygen and nitrogen. How the actual living substance—protoplasm—is related chemically to these compounds, is not yet

fully explained. Protein is the main constituent of protoplasm. Colloid compounds may be regarded as the intermediate stage between dead and living matter. Spontaneous generation of life takes place in this region now being investigated by colloid chemistry, which is building the bridge over the gulf between the organic and inorganic world.

There are no chemical substances or processes in organisms which cannot be imitated. Beginning with Woehler's manufacture of uric acid, a succession of biochemical compounds have been synthetically produced. The three primary classes of biochemical compounds associated with living cells—carbohydrates, fats and protein, —function in the juices of the cell as colloids or emulsions. It is becoming more and more evident that chemical changes can occur on the greatly extended surfaces of colloid particles. In these particular surface-reactions, probably, lies the key to many of the mysteries of life.

Finally, the latest development of bacteriology has practically eliminated the borderline between the dead and the living. The chemical compound of a cell does not possess life. The link between living and dead matter, therefore, must be somewhere bet-

ween the cell and the atom. D'Harelles' discovery of the bacteriophages definitely establishes this hypothesis. Life appears in the "world of neglected dimensions"—in the world of colloids that intervenes between the world of molecules studied by chemistry, and the phenomena covered by cytology.

In the last analysis we are up against the problem of another "missing link" down in the scale of evolution. The actual cycle of life is biogenetical. The break occurred once upon a time. We cannot reverse the process of the evolution of the earth from its fiery origin, to observe actually the first appearance of life. But the process can be reconstructed conceptually, and deductions made therefrom logically should be theoretically valid. Looking back upon the evolution of the earth, we can indicate a point where life could have spontaneously appeared in consequence of the operation of physico-chemical laws. Artificial creation of life is not an indispensable evidence for establishing this hypothesis. The decisive factor is the knowledge that it was so.

The phenomenon called life appears under certain definite physical conditions, which are absent except on the earth. That warrants the hypothesis that life is a chemical process, which takes place in a certain

physical state. Once in an earlier stage of evolution, the most primitive form of life appeared, it started on its own line of evolution. There began the cycle of life,—protista—plant—animal—decomposition into organic compounds—their absorption in the organic world. The original point of contact between the organic and inorganic world broke up. Therefore, spontaneous generation cannot be traced. It was an event in the past. It can only now be established logically. The fact that the cycle of life takes place in the context of the physical world, that inorganic matter is continuously going into the formation of organisms, that every point of the cycle is connected with the physical context, shows that life is conditional upon matter. The assumption that it is an independent category, whch uses matter as the means for its manifestation, cannot be taken seriously, unless there is a possibility of showing that life can exist by itself. That has been done neither by theological vitalism nor by the "scientific" neo-vitalism. Therefore, the origin of life can no longer be kept shrouded in a metaphysical mystery. It is in the process of the evolution of matter, which includes emergence of novelties. Life originated as a novelty in the context of the physical Universe.

CHAPTER IX

Neo-Vitalism

Notwithstanding Darwin's anxiety to avoid offending the traditional belief about the origin of life, to fight the atheistic, irreligious and immoral doctrine became the task of orthodox philosophy in the closing decades of the nineteenth century. Priests and professors fought shoulder to shoulder in the holy crusade. All the representative standard-bearers of the antiquated classical philosophy in the post-Hegelian period either vigorously combatted or superciliously ridiculed the revolutionary doctrine. Schopenhauer, for instance, loftily dismissed it as "cheap empiricism". Hartmann complacently declared that Darwinism would be consumed by its own logical consequences. The great Nietzsche, from the height of his vanity, looked down upon Darwin as a "mediocre intellect". Finally, the authority of Lamarck was invoked to refute Darwinism, at least, to correct its "extravagances".

The zoological philosophy of Lamarck was essentially materialistic. Therefore, it was usleess to call upon Lamarck's authority

in the struggle against Darwinism. In the latter half of the nineteenth century, it was no longer possible to make philosophical capital out of Lamarck's conventional reference to an useless God. The Neo-Lamarckists had to fight the master before they could enter the list against Darwinism. Lamarck held that the evolution of life was brought about mechanically by physical and chemical causes as the result of the striving for self-preservation. According to him, necessity is the cause of all adaptation. The Neo-Lamarckists detected some "psyche" or "vital force" lurking behind the necessity; and to establish their theory, they accused Lamarck of having given an unclear definition and expressed himself erroneously. They argued that Lamarck's doctrine of active adaptation of organisms to nature implied admission of the existence and operation of an immaterial vital force. On this particular point, Lamarck might have been somewhat ambiguous. The term "active adaptation" might lend itself to misinterpretation as opposed to the mechanistic theory. It might create the impression that Lamarck visualised a will underlying the process of adaptation. But on the whole, his work does not leave any room for such a construction of his doctrine. He was definite

that "the will is never free". He found necessity to be the lever of the mechanism of adaptation. But the neo-Lamarckists read a telelogical meaning in his clearly determinist view.

Scientifically, as well as philosophically, the conception of necessity is identical with the law of causality. The neo-Lamarckists disregarded the generally accepted meaning of a philosophical term, and placed a subjective interpretation on the word "necessity": Adaptation is the result of necessity, felt by the adapting subject—immaterial consciousness, ego or soul. A leading light of neo-Lamarckism, Adolf Wagner, wrote: "Whoever like Lamarck visualises necessity as the source of adaptation, he thinks psychically (that is, spiritually) through and through, however vague and even erroneous his definition might be. It cannot be denied that necessity is a psychical element, and whoever reduces all phenomena to necessity, he conceives nature psychically."

Lamarck himself had decidedly rejected the mediaeval theory of vital force, which split up nature into two parts—the inorganic and the organic. Besides, the least regard for scientific knowledge would not permit an open return to the religious philosophy of the Middle Ages. The neo-Lamarckists, there-

fore, sought to revive vitalism without openly breaking with science. They declared to have found in science itself the material to build a bridge between the **organa** and the **inorgana**. They admitted that the physico-chemical composition of organic nautre was not different from that of the inorganic, but asserted that the former was governed by special laws of its own, which presupposed a "life principle" which could not be physical.

Schopenhauer was the first to expound the doctrine of neo-viltalism; he also relied upon the authority of Lamarck for the purpose. He denounced the materialist view of life as "not only false, but positively stupid; highest point of absurdity; sheer nonsense." Schopenhauer's "will" at last found a scientific mooring when it identified itself with the neo-vitalist life-force. To preserve the scientific appearances of the resurrection of the soul, he energetically protested that the life-force, which was identical with his famous will, was entirely different from the "so-called soul". But as soon as he begins to tell us what it is, the cat comes out of the bag. It pervades the whole nature from the lowest inorganic stage to the highest form of life—in man. "A dark unconscious striving, a blind push." In the inorganic nature it operates as gravity, electricity, chemical

and psysical properties, etc. In the world of plants, it reacts to outside provocation; still it remains completely unintelligent. In animal and man, the will kindles the light of intelligence, and loses its instinctive infallibility. Schopenhauer's will is not a physical phenomenon, like the life-force of the neo-Lamarckists. It belongs to the metaphysical world. It is "the substratum of the entire nature, which we can find only in our inner self, but which at the same time remains always inexplicable." Despite all his protests, Schopenhauer endows his will with all the traditional attributes and elusiveness of the soul. He simply abused Lamarck when he expounded his neo-vitalism on the latter's authority.

To differentiate themselves from mediaeval theologians, the "scientific" neo-vitalists do not limit their "principle of life" to the organic world. According to them, it pervades the entire nature, as "the immanent principle of unity".

Adolf Wagner summarises the doctrine of his school as follows: "Old vitalism held that there was an absolute difference between the organic and the inorganic parts of nature. For the mechanists the unity of the entire nature is an axiomatic notion which, according to them, can be arrived at only (by

studying nature) from the bottom up. Neo-vitalism also looks upon nature as a unity, but holds that such a unitary conception is possible only through viewing nature from the top downwards." In other words, the soul, individually, and God, universally, are the points of departure of neo-vitalism. In our time, no reasonable person would take philosophy seriously unless it can offer a solution of the old problem of dualism. In search of a unitary view of things, philosophy gradually came under the materialist influence of science. Neo-vitalism is one of the numerous attempts to free philosophy from the undesirable association. It discovers the "possibility" for a unitary view of nature in a return to patheism, and consequently to mysticism, and full-blooded faith.

That is the opinion of Adolf Wagner himself. Some over-enthusiastic members of the school were carried a bit too far by their scientific conscience. They endeavoured to tackle the obvious impossibility of "explaining the principle of life" as distinct from the mechanical action of organic matter in a certain state of organisation. Wagner reprimanded those overenthusiasts in these words: "It is of no importance what the psychic principle is. The eternal mania for explanation must end once and for

all—a habit which has caused so much confusion. It should not bother us if we should ever be able to make a definite analysis of the psychic principle, experimentally and theoretically. Man cannot explain everything. In any case, not that which is to be taken for granted as the key for all explanation."

Thomas Hunt Morgan has contributed greatly to the elaboration of the theory of mutation, with the help of which biology consolidates the empirical foundation of philosophical materialism. Morgan's investigations in the obscure, sub-microscopic realm of genetics tear away the veil of mystery which previously shrouded the origin of life. As a matter of fact, Morgan goes to the extent of stating that in its simplest form "life is nothing more than a sunbeam glittering upon an atom of carbon". Nevertheless, he is distressed by the materialist deductions which logically follow from his own revolutionary achievements in the sphere of experimental science. He vigorously protests against what he calls "speculative interference in the realm of experimental science" ("The Scientific Basis of Evolution"). He won't have materialistic philosophical deductions made from scientific theories. While protesting against

"speculative interference", Morgan himself, however, leaves the ground of positive thinking and plunges in speculation in order to maintain that his contributions to experimental science do not support the application of the principle of determinism to the process of organic evolution. Morgan's philosophical views, of course, contradict the scientific theories elaborated by himself, and have been aptly characterised by a competent critic as "teleology with a vengeance".

In the futile effort to dispute the materialistic implications of his scientific discoveries, Morgan falls back upon the Leibizian semi-theological doctrine of a "pre-established harmony." Determinism is rejected in favour of an inscrutable providential arrangement; that is to say, of teleological predetermination. Empirical explanation is arbitrarily mystified. Positive knowledge is confused by an unwarranted mysticism. Reason is sacrificed on the altar of faith.

C. Lloyd-Morgan, as a scientist, also comes to the materialistic conclusion that "life emerges out of non-living matter". Three-quarters of a century ago, the unavoidable hypothesis of the spontaneous generation of life out of the background of inanimate nature compelled scientists like

Huxley, Haeckel and others, to support materialist philosophy all except in name. Since then, the hypothesis has been empirically established as a verified theory. To-day its materialist philosophical deduction is inescapable. Teleology has been dislodged from its last refuge. A biologist of our time, should he consistently and courageously stand by the necessary philosophical inferences of his scientific knowledge, could not take shelter in agnosticism, as Huxley and Haeckel did in their time. Yet, an eminent biologist like Lloyd-Morgan makes the vain effort to run away from the materialist philosophical conclusion of his discovery.

To defend spiritualism against the devastating assault of positive knowledge, Lloyd-Morgan takes up a strangely contradictory position. He admits that life emerges out of non-living matter; yet, he would distinguish mind from life, and is "not prepared to concede the possibility of mind Emerging out of life" ("The Emergence of Novelty").

Life has ceased to be a mystery; so, mind must be mystified with the object of finding a shelter for the imaginary spiritual essence of man. But physiology does not admit such tendencious mystification of the mind.

It conclusively proves that mind is a function of the brain, and as such is not a spiritual phenomenon, existing prior to and independent of the body. Lloyd-Morgan is "not so sure that man composed of body, mind and spirit can be adequately explained by processes of evolution. There is something elemental of which we may get intimation in course of the evolutionary process, but which cannot be explained by this process."

The subject is purposefully confused in order that it might appear to defy adequate explanation. The materiality of life is admitted; mind is the seat of mystery. But there is an obvious fallacy in the all too facile argument. In stating the component parts of man, spirit is differentiated from the mind: so, mind is neither body nor spirit. What is it, then? Moreover, life is not counted among the elements composing man. Presumably spirit and life are again identified. That is a hopeless confusion. The precision of scientific thought is discarded, so that a vague enunciation of categories might make room for "something elemental." But what is this mysterious inexplicable element, which is neither matter nor mind nor again spirit? Lloyd-Morgan's suggestion that mind is not a part of the biological process harks back to

scholastic rationalism.

The theological doctrine of the unity of mind and life was based upon the essentially correct Aristotelian view that life and mind are different manifestations of an identical thing. The scientific sense of Aristotle's conception got lost in metaphysical wilderness when it was taken over by Christian theology. Thomas Aquinas restated the Aristotelian view in a perverted sense. He emphatically insisted upon the impossibility of the existence of more than one vital force of essentially different nature in the same individual.

The nominalists, after them the men of the Renaissance, and finally the fathers of modern philosophy (Descartes and Bacon) conceived mind as an independent force in order to liberate reason from the domination of theology which taught that "life is the breath of God". In those days the declaration of the independence of mind, though scientifically incorrect, was a social and cultural necessity. But once the spiritualist doctrine of life was debunked, scholastic rationalism lost its usefulness. The historical revolt of man against theological tyranny, however, was not discerning enough to be discriminating.

Rationalist revolt against the theologi-

cal perversion of a scientifically correct view was vitiated by dualism. The fight for freedom of the mind degenerated into a new religion—of rationalism. In order to be a sovereign force, reason must have a supernatural origin. The erroneous dualist conception of life and mind persisted until the time of Cabanis, who demonstrated that psychology was an integral part of physiology. Comparative physiology eventually traced both life and mind back to an identical material origin. Spencer's inductive psychology, later on, explained mental phenomena physiologically.

Lloyd-Morgan relapses into dualism not even with the excuse which justified a similar philosophical error on the part of the fathers of classical rationalism. They erred in the enthusiasm of the struggle against theological tyranny. Scientific knowledge was not there to help them in that historic struggle. Lloyd-Morgan errs not under the pressure of similar untoward circumstances, but wilfully—to invent some excuse for a mystic spiritualism, a modern form of mediaeval theology.

But the conscience of a scientist revolts against the loose, groundless, metaphysical argumentation forced upon him by the expediency of defending a lost cause. There-

fore, Lloyd-Morgan asserts, presumably rather to quieten his own scientific conscience than to convince others, that "there is nothing inconsistent in interpreting all actual events in terms of evolutionary processes, and yet accepting the belief in a cosmic purpose." That is a relapse into blind faith, which is obviously not warranted. It is not necessary to assume a cosmic purpose which cannot be verified. It is not even an inscrutable factor mysteriously guiding the evolutionary processes. The assumption, therefore, is entirely unnecessary. Still, it must be made as an article of faith. Whenever driven to a tight corner, modern spiritualism is thus obliged to shed its philosophical pretensions and stand out in the pristine purity of faith, pure and simple.

Having arrived at the clearly materialistic conclusions that "life emerges out of non-living matter", and that "all actual events can be interpreted in terms of evolutionary processes," Lloyd-Morgan becomes uneasy. The "philosophical" anxiety to keep life shrouded in the traditional veil of mystery drives him to make self-contradictory statements.

The present state of biological knowledge hardly leaves any room for an im-

material vital force or the spiritual essence of man, and with the immaterial soul, God also must go. It can no longer be doubted that, until long after the evolution of organic matter, the mechanism of the physical Universe is without consciousness. To postulate at that stage an intelligent cosmic force is entirely gratuitous. Spontaneous generation of life may not have as yet been actually observed or demonstrated in the laboratory. Science may be confronted with the problem of another "missing link" at the very beginning of the chain of organic evolution. But the hypothesis that life grows out of the background of inanimate nature is as plausible as any other hypothesis of science. Actually, our knowledge on this crucial question is quite adequate to raise the unavoidable hypothesis to the status of a theory, which is logically sound, though not as yet experimentally verified. The present position may be stated as follows: It is quite conceivable that the present physical order of the Universe originally organised itself out of chaos, and that, once order was established in inanimate nature, life appeared mechanically out of a chemical compound occupying a position midway between organic and inorganic matter. (J.B.S. Haldane, "Science and Human Life").

Generally, that is not a new conception. The hypothesis of spontaneous generation was definitely set up by Huxley and Haeckel. Even before then, a whole succession of natural philosophers and biologists had been moving in that direction. Already in 1819, the German naturalist Oken had traced the origin of life to the "primitive slime". Then came Schultze's theory of protoplasm and Schwamm's discovery of the cell. In the middle of the nineteenth century, the French Academy of Science led by Pasteur was vehemently defending spontaneous generation. Haeckel's discovery of the **monera** placed the hypothesis on the sound basis of empirical knowledge. The **monera** occupies a place in the process of organic evolution very near to the recently discovered **bacteriophages,** which are considered by Haldane and other contemporary biologists to be the bridge between the **organa** and the **inorgana.**

Bergson also bases his essentially teleological doctrine of "creative evolution" on modern biological theories. But he rejects the view that organic evolution is the result of automatic adaptation to environment. He holds that evolution is purposive. Bergson argues that, from the point of view of physical excellence, organic evolution should have stopped before attaining the human level. In

support of this argument, he points out that some of the higher animals are better equipped than man physically to maintain themselves in the struggle for existence, and asks: If the motive power of evolution is to adapt organisms to their environments, why did it not stop at the elephant or the monkey? From the fact that evolution did not stop at that stage, but went ahead to produce the "physically deteriorated human species", Bergson concludes that evolution is the expression of an urge to create higher forms of life.

Even if Darwinism is brushed aside as antiquated, newer theories of modern biology are there to challenge Bergson's question as irrelevant. According to those theories, organic evolution is a purely mechanistic process which makes no room for any extraneous motive power. Besides, there are points of fact to be considered. It is not correct that the human species is physically deteriorated, compared to such other mammals as elephant and monkey. As regards the former, we need only point out the fact that it is a dying species, as refutation of the erroneous view which confounds bulkiness or muscular strength with physical superiority. It is equally incorrect to hold, as Bergson does, that monkeys are more

immune from disease than the human being, and therefore a physically superior species. Latest experiments (particularly those carried out by Landsteiner and Miller on American monkeys) show that the contrary is the case. Gout, for example, is a typical malady of the human body. Anthropoid apes are the only other mammals also susceptible to this disease. Its physiological cause is the inability to transform uric acid into other chemicals useful for the body. That inability is common to man and monkey. If the apes are not known to suffer from other diseases the reason is not that they are immune; it is simply that man's knowledge of their ailments is limited. They have not been subjected to anything like a clinical observation. Physical superiority in the form of bulk, muscular strength or the supposed immunity from disease, is more than counter-balanced by greater intelligence; the human being is more capable of adaptation and therefore more successful in the struggle for physical existence. Man as a whole stands higher than elephant and monkey in the scale of organic evolution, even from the physical point of view.

Bergson admits that man represents a higher form of life. But he doee not explain how life as expressed through the human

being is higher than that operating through "physically superior" organic forms like elephant and monkey. Evidently, superior intelligence places man higher in the scale of organic evolution. For these simple considerations, Bergson's arguments for proving the existence of an extraneous urge in organic evolution appear to be rather pointless.

However, leaving aside the factual inaccuracies in Bergson's argument, his rejection of the theory of mechanical adaptation can be countered with the following question, which is as pertinent as his, if not more so: Why should the purpose behind evolution, which presumably is of divine or metaphysical origin, take such a devious, wasteful course to realise itself? Why could it not create higher forms of life straightaway? It would seem that the frankly religious doctrine of creation is more rational than Bergson's "scientific" philosophy. A divine or spiritual force which requires material vehicles to accomplish its purpose cannot really be independent of matter.

Bergson solves the problem of material being by the simple contrivance of denying it. He holds that what materially exists is the force or stream of life, which he calls the

élan vital; what is regarded as organic matter, according to him, is an illusion! That is the central thesis of Bergson's famous book "The Creative Evolution", which contains practically the whole of his philosophy. All the multitudinous phenomena of the world, animate as well as inanimate, are but expressions of the all-pervading vital force, which is the basic stuff of the Universe. In order to explain the transitoriness of the expressions of the all-pervading stuff, Bergson visualises it in constant change. This property of the vital stream causes the process of organic and inorganic evolution. Thus, the events of the material world are only bubbles in an underlying stream of spiritual reality. But is it necessary to assume any such reality behind the constant changes of the physical world? These changes by themselves constitute a mechanistic process. Bergson's assumption of a purposive urge underlying organic evolution, therefore, is entirely gratuitous. The process of evolution is completely self-explanatory without any such **ad hoc** assumptions.

However, Bergson's view can pass at least as poetic fantasy, if not as philosophy, so long as intelligence is not attributed to

the vital force. In that case, scientific support would be utterly lacking. Whatever may be the nature of life, however much may be our ignorance about its origin, granted that its spontaneous generation out of a physico-chemical process cannot yet be proved, no biologist would, nevertheless, suggest that the lowest forms of life show any sign of intelligence. It is a well established fact that intelligence or purpose appears at a very late stage of organic evolution. Not to run up against this established biological fact, Bergson denies intelligence to his **elan vital,** which thus becomes a sort of spiritual mechanism. Yet, it is not quite a mechanism, in the usual sense of the term. The constant changes in the scheme of life, which appear as processes of evolution, are not guided by any intelligence; they are the expressions of an instinctive or intuitive urge. This is rather a sophistry than serious argument. Instinct or intuition is only the primitive form of intelligence; on the other hand, what is usually called an instinctive act is the result of the automatic operation of intelligence. Either way, instinct is not so absolutely different from intelligence as Bergson thinks.

According to him, instinct is the expres-

sion of truth, while intelligence is the source of ignorance. His philosophy seems to be that the child is wiser than the parent; the animal sees truth more clearly than the human being; the savage should be a more reliable guide than the civilised man! Therefore, we would be followng Bergson's teachings if we rejected the philosophical guidance of a highly civilised man like himself, and went to the bushman or the hottentot for more reliable wisdom.

A purposive urge without intelligence is a self-contraditory conception. Instinct or intuition may be arbitrarily distinguished from intelligence, but it clearly presupposes consciousness. In the last analysis, Bergson's **élan vital** is a new name for the old idea of cosmic consciousness. It is a grand fallacy. Because, science has not discovered any evidence of consciousness in the processes of physical evolution any more than it finds intelligence in life except in the higher forms. To evade this fallacy, Bergson abandons science and conceives the Universe as the self-expression of a mysterious being. This is a familiar doctrine. Hegel regarded the universal evolution as the means for the Absolute Idea to realise itself; and Schelling called the world self-contemplation of God. The gist of this

philosophy, restated by Bergson in a pseudo-scientific phraseology, is that nothing exists outside of consciousness. Just as the Universe is composed of an endless series of dream pictures, floating in the cosmic cloud of opium fumes, similarly is the world of each individual the projection of his consciousness which, in its turn, is a small eddy in the vast ocean of the cosmic cloud.

To let his fantasy have the fullest play with the idea of **élan vital,** Bergson brushes aside the troublesome concept of matter as an illusion. But one might ask: How is it that this illusion creeps in from all sides to mar the ethereal perfection of the dream pictures? It may be an illusion, but as an illusion it is there. Therefore, it is a reality. And as such, it demands an explanation. At this point, Bergson lets in intelligence as the devil of the drama. In course of evolution, intelligence appears on the scene and creates the illusion of the material world!

In his last book, Bergson writes: "The vital current that flows through matter and which is its **raison d'etre,** we simply assume as given." ("The Two Sources of Moral and Religion"). It is claimed that the assumption can be made "strictly within the limits of our biological knowledge." Bergson maintains that biology makes us acquainted

with the phenomena of life, but not with life itself to which he gives the new name of **élan vital**. Firstly, the distinction between life and the phenomena of life is arbitrary, indeed it is unscientific. Life is the sum total of its phenomena. Secondly, Bregson simply ignores the fact that experimentally life cannot be proved to be anything but a phenomenon of matter in a specific state of physico-chemical organisation. Evidence to that effect has been accumulating for some time. One of the latest, and the most authoritative, may be cited. The greatest living chemist of our time, Richard Willstaedter, addressing a convention of the American Chemical Society in 1933, declared that "life is definitely a chemical process"', and established this conclusion by a masterly exposition of his study of enzymes which, according to him, are "the pass-key to the secret of the chamber of life."

Having brushed aside the very basis of all biological knowledge, Bergson trots out the whole discredited doctrine of vital force with a new label, and dressed up in clever argumentations. The **élan vital** is visualised as a creative force which pervades matter, but is itself immaterial. This mysterious agency appears in man as love, and love is proclaimed as identical with God. Since

love is an emotion felt by man, the existence of God is experimentally established! With this ingenious argument, Bergson appears to turn the table on those who would charge him of following the theological method of starting from an **ad hoc** assumption. He argues that, of course, the existence of God cannot be proved, his nature cannot be known, if you begin with a certain idea about it. "One has a certain **a priori** representation, and holds it as the idea of God. Then one deduces what character the world (created by such a God) should have; and if the world does not possess those characters, one concludes that God does not exist." As against this method, Bergson formulates the following method of proving the existence of God, of knowing his nature experimentally.

"How is it possible not to see that, if philosophy is the product of experience and reason, it should follow the reverse method; it should ascertain what experience can teach us about a Being which transcends such reality as human consciousness, and then form opinion about the nature of God on the basis of what experience may have taught. Thus, the nature of God would appear as reason itself, in whose existence one must believe. Thus, one would not have to

deduce the existence or non-existence of God from an arbitrary conception of his nature. Agree on this point, and you will be able to speak without inconvenience of the divine Almighty. With the mystic, we find expressions of this kind, and therefore we look to him for divine experience. Evidently, the mystic understands thereby an indescribable force, a force of creation and love, that surpasses all imagination." ("The Two Sources of Moral and Religion").

The fallacy of this argument is palpable. How can we experience a being which admittedly transcends human consciousness? That which, by its very nature, is beyond our consciousness, obviously can never be the object of our experience. The proposition is to experience something which can never be experienced—not even in imagination. The absurd proposition is amended by the suggestion that there is such a thing as subconscious or superconscious experience attainable only in the state of beautitude. Since this sort of experience is not common, the report of the mystic is to be simply believed. With all his sophisticated argumentation, Bergson does not succeed in getting away from the old method of theology, which he appears to discard in favour of his "scientific" method of experiencing

God. The very idea of experiencing God presupposes the assumption that such a thing as God exists. Without that preconceived notion, the idea of experiencing God or knowing God experimentally could never arise.

The venerable doyen of the contemporary Western philosophy concentrates his intelligence and skill on an effort to find a new basis for religion and metaphysical morality, which might not be a flagrant contradiction of scientific knowledge. He subjects the traditional moral dogmas and religious doctrines to an analytical examination only to maintain that there is, there must be, an "open (standard of) morality", and a "dynamic religion", as against respectively "closed morality" and "static religion". These latter are held to be creation of human intelligence, and are found to be necessary means of restricting human nature for social stability. To expose the contradiction underlying this view, it is enough to recollect that, according to Bergson, intelligence is the source of ignorance. Now he argues that intelligence is necessary for social stability, although he also admits that social stability requires restriction of human nature. The ordinary mortal gets bewildered by this hair-splitting. Does the philo-

sopher stand for social stability or anarchy? Does he approve of the restriction of human nature by intelligence?The implication of his argument is that social stability is based on ignorance! One is bound to confuse, perhaps deliberately, the vital social and cultural issues directly concerning the daily life of man, when he insists on utilising biological knowledge for the purpose of restoring religion and metaphysical philosophy.

As against "closed morality" and "static religion", "open mortality" and "dynamic relgion" are expressions of the striving for freedom. They are instinctive; they transcend intelligence. The subconscious is the determining factor. Bergson grudgingly concedes to intelligence a subsidiary place in the scheme of human existence. The doctrine of the **elan vital** is expounded to arrive at this conclusion, to place intelligence at a heavy discount, so that a mystic spiritualist view of life may go unchallenged.

The old forms of religion and dogmatic morality based on them have been undermined by rationalism and scientific knowledge. In order to replace them by new forms and a new system of absolute morality, Bergson places religion beyond the reach of intelligence and reason. It is described as

an instinctive urge inherent in organic evolution. But the urge itself remains unexplained and consequently the whole structure of Bergson's new religious philosophy is a castle built in the air. It is an arbitrary assumption which has no place in the scheme of biological knowledge.

All human action, Bergson argues, is determined by a mysterious force which pervades the entire material being, but transcends intelligence. "Let us return to the salient features of life, and mark the strictly empirical characteristics of the conception of **élan vital.** Can the vital phenomena be reduced to physico-chemical facts? In answering this question in the affirmative, the physiologist simply maintains that the function of physiology is to search what physical and chemical elements are there in the vital phenomenon; that no limit should be set to this research; and that from there the research should go on as if there were no end to it. Thus only shall we go forward. The physiologist formulates a method; he does not enunciate a fact. Science is as far as ever from a physico-chemical explanation of life. This is what we should affirm first of all in talking of the **élan vital.**" ("Two sources of Moral and Religion").

Having thus assumed that there is something in life which is more than a physico-chemical combination, that is, something immaterial, Bergson turns to examine the evolution of the vital phenomenon. His point of departure naturally opens up before him a lot of mysterious corners and inexplicable phenomena in the evolution of life. Consequently, he indicates "this inadequacy of Darwinism" as another argument in support of the doctrine of **elan vital**. But Bergson is too much of a scientist to dismiss biology altogether. He seeks to prove that biology itself brings us face to face with the mysterious force which "baffles our intelligence and compels us to believe in the existence and operation of an inscrutable divine." Having affirmed that "life evolved in determined directions", he asks: "Now, are these directions imposed upon life by conditions, or life evolves those conditions?" In answer, it is asserted that the regularity of organic evolution is not the mechanical action of external causes; that it is an internal urge which guides it in a given direction—to higher and higher complications.

The very mechanism of the process of biological evolution is interpreted as its "internal urge". The processes of biological

evolution are not determined by "external causes". They are self-contained. Adaptation is not the operation of any external cause. The organism adapts itself to environments. The "urge" is inherent in the self-contained process of evolution. So, all Bergson's arguments for establishing the doctrine of **élan vital** are irrelevant and pointless.

The philosopher himself is compelled to admit that all these and many other arguments do not prove the existence of the mysterious force; that the conception of the **élan vital** "does not offer a better explanation" of life; "we only point out the mysterious character of life. If life is not to be reduced to physico-chemical facts, then it operates as a special cause in addition to what we call matter. Thus, matter is an instrument of as well as an obstacle" to life.

An **ad hoc,** admittedly gratuitous, assumption must be made, "if life is not to be reduced to physico-chemical facts". That is the sum total of Bergson's argument. This is evidently not establishing neo-vitalism on the basis of biological knowledge. It is to brush aside biological knowledge for the sake of a preconceived notion.

Bergson's new doctrine of **élan vital** culminates in a conception of life analogous

to the Hindu idea of the relation between body and soul. The body, that is the physical being, is necessary for the immaterial soul to work out its liberation; but at the same time, it is a bondage. Bergson does not reject science outright, although, perhaps in an unguarded moment, he argues that his essentially theological "scientific philosophy" must be accepted, "if life is not to be reduced to physico-chemical facts". He makes capital out of the imperfections of scientific knowledge with the purpose of building a new temple for the goddess of faith.

To declare, as he does, that physiology "does not enunciate a fact", but simply formulates a method, is to dispute that there is such a thing as scientific truth. It is to assert that the mysteries of the biological evolution as well as of the entire physical Universe are never to be penetrated by human intelligence. Granted, for the sake of argument, that our present knowledge about the vital phenomena is not conclusive, it does not follow that physiological discoveries are not facts relating to life, and explaining (though as yet incompletely) the nature thereof. Phenomena previously attributed to the operation of an immaterial force have now been conclusively proved to

be purely physico-chemical. Therefore, there is absolutely no logic in the hypothesis that a mysterious force lurks behind those phenomena of life which are not yet quite satisfactorily proved to be also physico-chemical.

Science does not explain completely all the phenomena of life. Philosophy might be justified in its supercilious attitude, if it offered a better explanation. But it does not. Bergson himself admits that "making an **elan vital** intervene in the situation, we do not give a better explanation; but we indicate the mysterious operation of life." This is philosophy of mystification. You start by doubting or disputing the validity of scientific theories on the ground that they do not completely solve the problems they treat. Logically, you are expected to give us a better explanation. The contention that life is not what science has discovered it to be can be maintained only by proving positively and definitely that it is something different. That is not done. Only the assertion is made that life is something different, and that we are ignorant about its nature. If we are ignorant about it, how can we assert that it is not what science has proved it to be? Such an assertion presupposes a knowledge on our part. But to explain

nature is not a part of the spiritualist philosophy. Its function is to raise an insurmountable wall between the mysteries of nature and human understanding.

CHAPTER X

Materialism

Except thorough-going idealists, either of the Berkeleian or the Neo-Platonic school, no modern philosopher disputed the existence of the so-called external world; the doubt was about the possibility of knowing it. How far did knowledge correspond with objective reality? Has epistemology any ontological reference? If modern scientific theories have any negative philosophical significance, it is only to encourage those old questions of epistemology, and consequently drive philosophical speculation back to Humean agnosticism.

The great materialist thinkers of the seventeenth century (Hobbes, Bacon, Locke), whose views became the object of Berkeley's attack, held that ideas were but abstractions of the images of external objects, received by the senses, and that therefore the external objects were unconditionally knowable. The French Encyclopedists in the following century called "those who, conscious only of their own existence and of a succession of external sensations,

do not admit anything else, protagonists of an extravagant system, the off-spring of blindness itself." (Diderot). They definitely held the view that senses gave true representation of outside objects, and sense perceptions were the only source of knowledge.

At that stage, the problem of perception baffled epistemology. Hume's agnosticism was born out of that problem. He did not deny the objective reality of the external world, but doubted the possibility of knowing it. He agreed with Locke that sense perception was the only source of knowledge. But he would not go farther to enquire into the nature of the things perceived, holding that any such "speculation" would be indulging in fruitless metaphysics. However, the great question that had agitated human intelligence from the dawn of civilisation still remained to be answered, and it must be definitely answered once for all, if philosophy was to perform its function. Either we can know, or cannot know, the reality; sense perceptions are either reliable, as correct representations of objectively existing things, or they are not. The entire history of civilisation provides a rich store of materials for the final solution of the basic question of epistemology. The phenomenal development of the natural sciences in the

last century enabled free thinkers—free in the sense of not being bound by traditions and preconceived notions—to answer the fundamental question of philosophy decisively in the affirmative.

The "crisis of physics" at the end of the nineteenth century induced great scientists like Mach, Poincaré, Oswald and others, to expound what was called positivism: Philosophy should not go beyond actual experience. But presently the atom survived the crisis, to become the subject matter of an entirely new branch of physics. In the field of philosophy the fashionable school of positivism could hold its own only by relapsing into agnosticism. A whole gallaxy of new schools developed with the object of harmonising philosophy with scientific knowledge on the basis of a synthesis of Idealism and Materialism. The more important among them were: Critical Realism, New Realism and Pan-Psychism; Russell's Neutral Monism also deserves mention, because its expounder stated the common point of departure of all these systems as follows:

"We must, therefore, find an interpretation of physics which gives a due place to perception; if not, we have no right to appeal to the empirical evidence. This problem has two parts: to assimilate the physical world

to the world of perceptions, and to assimilate the world of perceptions to the physical world. Physics must be interpreted in a way which tends towards Idealism, and perception in a way which tends towards Materialism. I believe that matter is less material, and mind less mental, than is commonly supposed." (The Analysis of Matter").

The problem as stated by Russell might have appeared to be baffling when he wrote; but since then, it has been discovered, and readily conceded by Materialists, that scientific theories, particularly the recondite equations of mathematical physics, are very largely "ideal", mind having so much to do with them as to push their ontological reference to the background. Therefore, what is needed is not an idealistic interpretation of physical theories, as Russell suggests, but simply recognition of the fact that the mind of the scientist is a part of the physical world he studies.

How philosophy is affected by the discoveries of modern science, is better described by Broad: "The original belief of commonsense was vague, crude and unanalysed. Berkeley's arguments have forced us to recognise a number of distinctions and to define much more clearly what we mean by the statement that chairs and tables exist un-

perceived. The original crude belief consisted of a number of beliefs. Berkeley's arguments really do refute or throw grave doubt on some of them, but they leave others standing. Those which are left are enough to constitute a belief in the independent reality of external objects. This final belief in the reality of the external world is much clearer and subtler. It has been purified of irrelevant facts." (Scientific Thought").

Yet, in another place of the same book, Broad writes: "It is no part of my duty to pay compliments to Matter, and so long as we state clearly what we do mean, it is of little importance whether our terms be used in a literal sense or in a highly Pickwickian sense. It will be a question of taste whether it shall be said that the theory that we finally adopt amounts to the acceptance or denial of matter." With his academic neutrality, the philosopher would not mind if he is accused of saying that "matter is not matter"! Is it not a typical case of "shame-faced Materialism"—the epithet used by Engels to describe the agnosticism and positivism of his time? A contemporary has christened this non-committal attitude as "pseudo-realism". (R. W. Sellar, "The Philosophy of Physical Realism").

The two schools of Realism—New and

Critical (there is little of essential difference) —hold that the basic category of philosophy is "external relations"; that it is metaphysical speculation to talk of things, objects, matter, substance. The fundamental fallacy of these fashionable philosophies is to ignore an elementary logical question: Does not relation presuppose things related? Russell's "events" do not help the new and critical realists out of the difficulty. The concept is taken over from Relativity Physics; but there, it has a clear spatio-temporal connotation. All these efforts to create confusion about the philosophical consequences of modern scientific research, however, are futile.

Materialism can no longer be assailed on the ground of science. Philosophising scientists like Eddington, Jeans and others, might hold that the so-called physical world is made of "mind-stuff", but bold opponents of Materialism know that psycho-physical parallelism is their only dependable weapon; in order to prove the existence of disembodied spirit, or disembodied mind, (to be more modern), they decline to accept the evidence of science as final. G. F. Stout is the stoutest amongst the uncompromising opponents of Materialism. He is constrained to admit that approaching the problem of the relation between mind and matter" by way of the re-

lation of body and mind, I find myself confronted directly with the **prima facie** scientific evidence in favour of Materialism, and in dealing with it, I have to think and speak in terms of causality and other categories of the physical sciences. I do so because there is no other way of meeting Materialism on its own ground." ("Mind and Matter"). Stout, therefore, shirks the ground of science for his encounter with Materialism. Why? Because, "the procedure is unphilosophical." He laments that, taking their stand on the slippery way of meeting your adversary on his own ground, even redoubtable Berkeley and after him Bosanquet actually proved the case of Materialism. For this consideration, admitting that the philosophical consequence of modern scientific research is to reinforce Materialism, Stout evades the main issue of ontology as well as of epistemology, and fights Materialism with the rusty weapon of the faith in a universal mind.

"We are not concerned with Materialism as a purely scientific generalisation, but as a metaphysical theory claiming to be based on scientific evidence. We assume that from the standpoint of science mind and mental occurences are found to exist when, and only when, certain material processes

take place in living bodies. I shall argue that the beginning of this or that mind essentially depends on pre-existing minds; in other words, that mind in general is not produced at all, but is, in some way, involved as a primary factor in the original constitution of the Universe." ("Mind and Matter").

In making this assertion, without caring to disprove that Materialism as a metaphysical theory, that is to say, philosophy, is based on scientific evidence, Stout admittedly uses the terms, mind and mental, as essentially involving experience. There he begins to contradict himself: Mind involves experience, but at the same time it is independent of experience! Only as such can mind ever be disembodied. And mind has to be disembodied, because otherwise it cannot be universalised. The psycho-physical parallelism is as incomplete in Stout as it was in Descartes. The contradictions of this doctrine as expounded by the father of modern classical Idealism, logically led to Materialism. Refurbished by Stout, even when we know so much more about psychology as well as physics, the self-contradictory doctrine cannot be any more stable. Therefore, Stout falls back on full-blooded faith. His disembodied mind is the old disembodied spirit of religious philosophy. It has abso-

lutely nothing to do with science. The existence of a universal mind cannot simply be proved scientifically. It is an article of faith, pure and simple.

Psycho-physical parallelism is no longer a problem, and much less a fact. That is conceded even by contemporary philosophers who expressly disown Materialism. Alexander, for example, writes: "The mind is a thing which has its proper place assigned to it in the scheme of things. If such a doctrine is called Naturalism, I am content to be with Spinoza, and can claim that a Naturalism, like his, admits all the human things of worth. At any rate, I have in accordance with this principle described consciousness as a quality of a certain sort of nervous organisation, in a certain condition of functioning, and in order to mark the distinctness of the two partners in the situation of knowing —the mind or body, on one side, and the object on the other—I say that in any such transaction the mind enjoys itself and the object is contemplated. The enjoyment is at once a state of being of the mind itself, and that to which the object is revealed, and so is an act of knowing. Reciprocally, in knowing the object, I know myself, not in the sense that I contemplate myself, for I do not do so, but in the sense that I live through

this experience of myself." ("Space, Time and Deity").

Modern scientific research shows that there is a large subjective element in our knowledge of the external world. That discovery, it is held, repudiates Materialism, which is accused of denying the existence of mind as something differentiated from the processes of the biological world, governed by its own laws. The basic principle of Materialism, as corroborated and reinforced by modern scientific research, however, is that the world, physical as well as biological, exists objectively, is self-contained and self-explained; there is nothing beyond and outside it; its being and becoming are governed by laws inherent in itself; laws are neither mysterious nor metaphysical, nor merely conventional; they are coherent relations of events; consciousness, with its manifestations and derivatives, is a property of that which, in a certain state of organisation, distinguishes existence from non-existence. Call this philosophical generalisation of the various branches of scientific knowledge, objectivism, naturalism or realism, or by any other name you prefer to Materialism. That would make no essential difference. Only, the term "matter" has a historical meaning; it rules out illusions and superstitions, which

debase philosophy into religion. If the metaphysical generalisation of scientific knowledge was given a name which has a definite meaning, the Neo-Platonic devagations of Whitehead, for instance, would be obviated.

In the name of "rationalism", Whitehead demands "more concrete survey of the whole of reality"; and by doing so, intuition or religious experience is granted greater validity than exact knowledge. Science itself is ditched with its materialist philosophical consequences. "The material, the space, the time, the various laws concerning the transition of material configurations, are taken as ultimate, stubborn facts, not to be tampered with." (A. N. Whitehead "Science and the Modern World"). Philosophers would not accept that position. They "are rationalists. They are seeking to go behind stubborn and irreducible facts; they wish to explain in the light of universal principles the mutual reference between the various details entering into the flux of things." (Ibid.)

If the ground of logic and "pure thought" is chosen to challenge the scientific sanction of Materialism, then, the gauntlet is taken up by asking: How are the unfailing and infallible "universal principles" to be known? Presumably, through intuition:

they are revealed truths! Faith is raised to the dignity of rationalism.

The ultimate category of Whitehead's rational philosophy is also the hypothesis of a universal mind or soul. The old problem of psycho-physical parallelism is trotted out. Can Materialism solve it with the help of modern scientific knowledge? How can mind result from matter? Has matter the capacity to organise itself into things like ourselves? Before summarising the reply of modern science, which reinforces Materialism, let us see how the problem is solved by its opponents.

"All that is required is that mind shall through and through enter into the constitution of matter and give to natural processes a character and implications which could not belong to them if they were merely material. The mind operative in nature may express itself in various ways. The emergence of experiencing individuals at certain stages in the course of natural process is one among others. If this view turns to be the only tenable view, the argument against Materialism is virtually an argument for the existence of God and the universal and eternal mind." (G. F. Stout, "Mind and Matter").

Those who would rather be satisfied

with that philosophy are welcome to please themselves; but evidently, they cannot claim that their philosophy is the consequence of modern scientific research.

Biology does show that matter has the capacity to organise itself into complex, conscious, knowing, thinking beings. It makes no essential difference that we do not know as yet exactly how that capacity of matter to produce life operates. That is an epistemological, not ontological, question. The capacity is there, only we do not know how it operates. Anyhow, it is proved beyond doubt that consciousness and mind (if the grotesque notion of disembodied mind is excluded) are functions of organic matter. That discovery cuts at the root of the matter mind problem. Materialism does not exclude emergence of novelty. The possibility of mind knowing or contemplating the material world presupposes causal connection between mind and matter; there must be something common between them. If mind was entirely different from matter, there could be no inter-penetration. Knowledge is possible because mind results from matter. Matter, or non-mental being, if you please, has no end. It is simply given—as the existence. Therefore, the question of explaining its genesis does not arise. Beyond a rather

advanced stage in the process of biological evolution, dualism disappears, in the material unity.

Materialism does not deny the empirical fact that purpose is associated with embodied spirits; it only exposes the absurdity of the notion of disembodied spirit, and does that on the evidence of scientific knowledge. But purpose is not a metaphysical agency operating through material bodies. It does not precede physical being; on the contrary, it grows out of the material matrix of the process of biological evolution. Reinforced by modern scientific knowledge, Materialism thus not only solves the old problem of psycho-physical parallelism; it also reconciles another old conflict—that between rationalism and naturalism, or romanticism. It harmonises the positive elements in both.

CHAPTER XI

A Scientific Theory of Knowledge

A more accurate formulation of the generally correct causal theory, together with a corresponding clarification of the old realistic doctrine of "representative idea," gives us the theory of knowledge which results from modern physical research. To put it differently, the result of modern physical research, supplemented by the latest contributions of biology and psychology, enables us to free the empirical theory of knowledge from the fallacy and ambiguity which caused its degeneration into subjectivism.

The causal theory as formulated by Locke confounded sensation with perception. Consequently, on the one hand, sensation came to be regarded, **erroneously,** as a state of mind; and, on the other hand, mind was reduced to a passive observer of pictures presented to it. An analysis of sensation, in the revealing light of modern scientific knowledge, shows the way out of the impasse. Perception is not caused by external agencies, as the old causal theory held; external stimuli cause **sensations** which are perceived by the mind.

Mind being a complicated state of consciousness, which itself originates as the reaction to sensations, the baffling question, how could states of mind be caused by non-mental agencies? does not arise; and it becomes possible to restate the doctrine of representative idea in a form which does not lead to Idealism. Knowledge is possible because there is a causal connection between mind and matter.

Ideas are representative of realities in as much as they are derived from experience. I must know a thing before I can have an idea of it. But ideas are mental pictures; **they represent the knowledge of things, not things themselves.** If I am incorrectly informed about a thing, my idea of it will be false. Yet, it will be "representative"—of my distorted knowledge. Knowledge results from perception, which is organic reaction to physical contacts. **We know things, not ideas.** Knowledge is not composed of ideas; on the contrary, ideas are derivatives of knowledge. That is how ideas can be representative, and scientific ideas are representative.

The analysis of sensations and the resulting insight into the process of cognition enables us to reverse the falsely conceived traditional relation between knowledge and

ideas. The representativeness of ideas does not result from their identity with sensations. Ideas, being products of the interaction between the mental and the physical, cannot circumscribe the radius of the mind's reach. They result from mental activity; the cause is never limited by its effect. Berkeley's famous argument that ideas could be only like themselves no longer serves the purpose with which it was advanced. Ideas, of course, are mental pictures; but mind is not limited to the contemplation of those pictures, which are products of the cognitive action of mind. Besides, ideas are entirely different from what Berkeley conceived them to be. His argument was based on the false identification of ideas with sensations. Therefore, it is utterly irrelevant to ideas as they really are. Since the very existence of ideas is conditional upon knowledge, it is palpably absurd to assert that we know only our ideas.

Thus restated, the doctrine of representative ideas becomes compatible with the results of modern physical research, which compel revision of some preconceived notions about the structure of the Universe and laws governing it. To be representative, ideas must correspond with things as they really are. If the world of experience is

characterised by the absence of absoluteness, ideas about it also must have that character. In other words, they must change according to the knowledge of the world. The representative character of ideas is relative, because it is necessarily proportional to the extent and accuracy of knowledge. At each given moment, ideas depict things as we know them to be, or as much of them as we know for the moment. Ideas correspond not with things, but with objects.

In formulating a scientific theory of knowledge, the **object** must be clearly differentiated from the **thing**. The one is an epistemological category; the other, ontological. **An object is a thing perceived.** The two are not identical, ontologically. Objects are always things; that is to say, they are existentially real. **Sensa** also are things; even ideas are mental pictures, and picture is a spatial concept. But things are not always objects—of perception or of knowledge. They may exist, many do exist, without attaining the epistemological state of being "objects". America existed before it was discovered; so did the planet Uranius.

Again, an object of my knowledge is not always and necessarily the whole of the thing, the contact with which stimulates in me the organic faculty of cognition. Incom-

pleteness of the knowledge of a thing does not affect its objectivity. Besides, **as objective knowledge, it is complete,** because it covers the parts of the thing actually perceived. As regards the thing, it is not complete; but as regards the object, it is. Therefore, scientific knowledge is always objective, although ideas resulting from it may change from time to time. Being based on objective knowlege, all scientific ideas are representative—of realities. If a thing is real, its parts are also real. The failure to distinguish between the object and the thing has been the cause of much epistemological muddle. The emphasis laid on the fact that objects are always associated with mind, are in a way mind-dependent, has obscured the objectivity, that is to say, their ontological reality, which consists of their being the perceived aspects of parts of things. But to be dependent on mind is not to be states of mind. Yet, the proposition that the immediate content of knowledge is states of mind is predicated on the false argument that, because objects are mind-dependent, they must be states of mind, their existence consists of being perceived. That is how physiological processes (sensations) caused by external agencies came to be regarded as states of mind, and empiricism degenerated

into subjectivism, which is denial of the possibility of knowledge.

The way out of this muddle lies in the realisation of the fact that, while epistemologically objects are mind-dependent, existentially they are independent. Perception is perception of things; it leads to the knowledge of the external world, although what is directly perceived is sensation. When modern science shows that sensations are not only electro-chemical processes, independent of, and anterior to, mind, in the history of organic evolution, but actually are events in the physical continuum called the "external world", it becomes abundantly clear how knowledge is acquired. Knowledge is possible because mind is a highly developed, extremely complicated, state of consciousness, a property of living beings (of higher order) to react to external stimuli.

The central point of a correct theory of knowledge is that cognition is a relation between mind and the world. Knowledge is objective and subjective, at the same time. Both the corelates—the knowing self and the world known—are equally vital. To solve its problems, epistemology must start from the ontological reality of mind as well as of the external world. For epistemology, the question of precedence is irrelevant. That

is a question of ontology. Epistemology must be simply guided by the facts that mind exists, and that knowledge is conditional as much on the existence of mind as on that of matter. Such a point of departure does not involve any admission of psycho-physical parallelism, either in the individual or on the universal scale. Mind is real because it is a part of the physical world. This finding of biology enables us to regard mind as an empirical category; and it makes the decisive contribution to the formulation of a correct theory of knowledge. It is also the objective theory of knowledge, because it objectifies the self itself.

Knowledge presupposes a conscious being differentiated from the rest of nature; but the latter grows out of the background of a physical continuum and remains embedded therein. "External world" is a misleading term. We are integral parts of the world of our experience. The mind of others belongs to my "external world" just as their bodies. And my mind belongs to the "external world" of others. Self is always an embodied self. The knowing mind can never be conceived as a disembodied spirit. The conception of self includes the corporeal being. Our bodies, organs of sensation, the nervous system, the brain, the

entire cognitive apparatus, are parts of the physical world. We do not watch the world as outsiders. Our egos, our minds, our thoughts, our intelligence, are all interwoven with the physical processes of the "external world". This does not imply an uncritical endorsement of the questionable doctrine of the identity of thought and being. The point is that thought (all kind of mental activity) is a function of organic beings on a very high level. Thought presupposes, is conditional upon, being. The subjective elements of the process of cognition are parts of the all-embracing complex of physical nature. The exclusion of the metaphysical concept of disembodied spirit, rejected even by those who wish to establish the universality of mind empirically, and the consequent disappearance of psycho-physical parallelism, guarantee the objectivity of empirical knowledge. And all knowledge is always empirical, conceptual thought, the highly abstract theoretical structure of mathematical physics, being no exception.

Life is the immediate foundation of mind. In the absence of life, the existence of mind cannot be proved. Life being a phenomenon of physical nature, mind also is a part of nature. The activities of our own

minds are events in the physical world, which is outside of ourselves. The very act of perceiving, knowledge, thinking, takes us beyond ourselves. Therefore, even introspection or self-contemplation is not purely subjective. Even the most intimate mental act has an objective reference.

Knowing is an act of mind; knowledge, however, is not identical with thought any more than thought is identical with being. Thought is mind's property, whereas knowledge is a possession. The distinction is fundamental. The one is inherent, an inalienable quality; whereas the other is acquired —from outside. To think is in the nature of mind; but it may or may not possess some particular knowledge. Knowledge is possessed by mind; it exists in the mind; but it is not of the mind. It is knowledge of what exists outside the mind. Therefore, ontologically, it is not identical with mind.

But knowing, as a mental act, is subjective; knowledge is something acquired by mind, and what is acquired can neither be identical with, nor born of, the acquisitor itself. The fact that knowledge is acquired, has to be acquired, proves that it is not manufactured by mind, independently of the external world. Nor is it, on the other hand, identical with the object. It is the result of

a relation, and, as such, equally dependent on both the related terms. But once it is there, it acquires an existential reality of its own. Scientists die; knowledge of nature won by them survives. On the other hand, things disappear in the abyss of time, but knowledge about them remains a human heritage, unless it also is somehow destroyed as any other thing. Knowledge is a thing—a peculiar kind of thing, but a thing nonetheless. That is why it is objective. Genetically dependent, existentially, it is self-sufficient; and functionally, creative. Product of mental activity (to be distinguished from mind), it changes the mind. This could not be, if mental activities were limited to mind itself, if ideas were the content of knowledge. Ideas transform mind, because, resulting from the knowledge of the external world, they increase the mental outfit. Mind is the organic faculty to know. The greater the knowledge, the sharper the faculty. Primitive consciousness is the foundation of mind; at the same time, it is the simplest form of knowledge; and itself, it is a mechanical property of organic matter, in a definite chemical state. Thus, nothing immaterial enters into the process of cognition which, as a process involving different material entities, is entirely governed by the mechanical

laws of physical nature.

To sum up: Sensations are bodily events, causally connected with the external world. There is no interruption in the causal chain. All sensations, in the last analysis, are tactual. Knowing as well as perception takes place on the plane of direct physical contact. The causal chain throughout is physical, not logical. Therefore, all arguments of the subjectivist are irrelevant. The outer link, relation between sensations and their external causes, is similar to the causal connection between events in the physical world. It is governed demonstrably by physical laws. The middle-link is the neural connection between the organs of sensation and the brain. Here we have to do with the organic property of reaction to stimuli. The process is electro-chemical, also subject to physical laws. Perception, thus, is no mystery. Perception as well as sensation is an event in the physical continuum which includes the body. It, therefore, puts mind in direct contact with the external world. It is not a contact between two qualitatively different entities. Mind itself originates in the organic property of reaction to stimuli. So, the last link, cognition, also is a physical relation.

Cognition, however, is not a tacit recep-

tion or recording of messages from the external world. The messages are stimuli; cognition is intelligent reaction to them. Perception is an automatic organic reaction. Cognition is an interpretative, denotative, selective, act. Knowledge is not a mere conglomeration of messages received at random. It is a characterising judgment about the nature of things from which the messages come. Perception makes us conscious of the existence of things; cognition is insight into their nature afforded by perceptual data. Higher organisms (with developed brains) possess the faculty not only of receiving impressions of the environment, but also that of weaving them into a coherent mental picture of the physical reality they represent.

Experience is the foundation of knowledge. But knowing is not a purely empirical process. It is selecting, interpreting, systematising, coordinating, of empirical materials—sense data—in a rational, logically coherent, explanation of perceptual facts. In building this conceptual picture of the world, mind is not limited by
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knowledge results from the constant and continuous reference of percepts to their external sources. That is done in various ways—actions of daily life, planned experiment, intelligent observation, memory, logic, thought and the domination of the "unconscious" on all our conscious behaviour. "The fibres of the external world run into our consciousness". Brain is composed of our end of the fibres. So, brain processes can be traced back, along the fibres, to their physical causes in the remotest parts of the Universe. Mental activities are cerebral functions. The mind is causally connected with the whole of the physical Universe. It is not circumscribed by the events taking place in its body. Reacting to those events, it goes out to the external world, conceptually.

Knowing is a matter of logically tracing the lines of physical causality from the contents of immediate experience outwards. Percepts are purely empirical entities. Concepts are synthetic. The former are automatically given. The latter are consciously constructed. Knowledge is a conceptual scheme born out of the insight into the nature of things, gained through critical examination, rational co-ordination and logical deduction of perceptual data.